SPECIAL COLLECTOR'S EDITION

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electronics today INTERNATIONAL

APRIL 1982 85p

10th BIRTHDAY ISSUE!

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A Digital Multimeter

A Hi-Fi Amplifier • A Computer

Plus Much More ......

24 Page Supplement Inside

..AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS..

POWER PACKED — by POWERTRAN

Powertran's black boxes are packed with punch. Not only are they superb kits to buy and build they really do the job! Imaginative and ingenious design goes hand in hand with top quality materials and outstanding performance capability. With their smart black styling the kits harmonise visually as well as musically.
Your can built each unit independantly for its set task and then gradually increase your array until you have a complete bank of formidable controllable power.

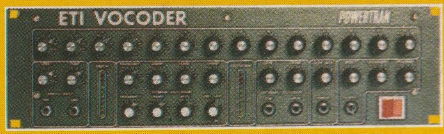
THE FIRST WORDS AND THE LAST WORD IN ELECTRONIC KITS — SEE OUTSIDE BACK COVER OF THIS ISSUE!

Complete Kit — **£49.90** + VAT

MPA 200 is a low price, high power 100W amplifier. Its smart styling, professional appearance and performance, make it one of our most popular designs. With adaptable inputs the mixer accepts a variety of sources yet straightforward construction makes it ideal for the first-time builder.

Complete Kit — **£49.50** + VAT

CHROMATHEQUE 5000 — a 5-channel lighting system powerful enough for professional discos yet controllable for home-effects. Sound to light, strobe to music level, random or sequential effects — each channel can handle up to 500W yet minimal wiring is needed with our unique single-board design.



Complete Kit — **£175.00** + VAT

ETI VOCODER — 14 channels, each with independent level control, for maximum versatility and intelligibility; Two input amplifiers — for speech/excitation — each with level control and tone control. The Vocoder is a powerful yet flexible machine that is interesting to build and thanks to our easy to follow construction manual, is within the capability of most enthusiasts.

Complete Kit — **£64.90** + VAT

SP2 200 twice the power with two of the reliable, durable and economic amps from the MPA200; fed by separate power supplies from a common toroidal transformer. Superb finish and quality components throughout — up to (even over!) the standard of high priced factory-built units.

DJ90 Stereo Mixer — this is a really versatile new mixer that enables the constructor DJ to produce a professional performance every time. There are two stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Other 'plus' features are auto-panning for fast or slow, slider controls, multi-mixing, ducking, interrupt, input modulation, in short everything . . . the whole works — AND — under £100 complete! (We have illustrated the DJ90 teamed in our own console with the Chromatheque and an SP2 200 and speakers.

Complete Kit — **£97.50** + VAT

Digital Delay Line — our latest kit! With its ability to give delay times from 1.6 mSecs to up to 1.6 secs. Many powerful effects including phasing, flanging, A.D.T., chorus, echo & vibrato are obtained. The basic kit is extended in 400 mS steps up to 1.6 secs. Simply by adding more parts to the PCB. Compare with units costing over £1,000! Complete kit (400 mS delay) **£135**. Parts for extra 400 mS delay £9.50p.

. . . . Quite simply the best way to make music

WORLD LEADERS IN ELECTRONIC KITS

- **Money Back Guarantee** — If you are not completely satisfied with your Powertran Kit return it in original condition within 10 days for full refund.
- **Free Soldering Practice Kit** — To assist the beginner we will supply, on request with your first kit order, a free soldering practice kit with useful tips and illustrations.
- **Component Packs** — Most kits are available as separate packs (e.g. PCB component sets, hardware sets etc). Prices in our FREE catalogue.
- **Ordering** — Full ordering details, delivery service, and sales counter opening — outside back of this issue.

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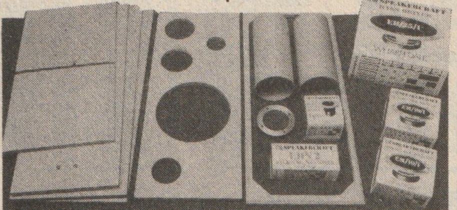

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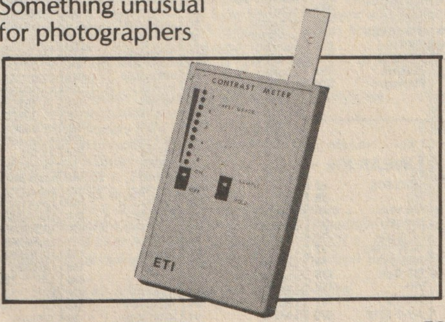

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ROBOT CONTROLLER PART 2 94
For producing PWM

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ELECTROLYTIC CAPACITORS: (Values are in µF) **500V**: 10 **52p**; 47 **78p**; **63V**: 0.47, 1.0, 1.5, 2.2, 3.3 **8p**; 4.7 **9p**; 6.8, 10 **10p**; 15, 22, **12p**; 33 **15p**; 47 **12p**; 100, **19p**; 1000 **70p**. **50V**: 47 **12p**; 68 **20p**; 220 **24p**; 470 **32p**; 2200 **90p**. **40V**: 4.7, 15, 22 **9p**; 3300, **90p**; 4700, **120p**; **25V**: 1.5, 6.8, 10, 22 **8p**; 33 **9p**; 47 **8p**; 100 **11p**; 150 **12p**; 220, **15p**; 330 **22p**; 470 **25p**; 680, 1000, **34p**; 2200, **50p**; 3300, **76p**; 4700 **92p**; **16V**: 40, 47, 100 **9p**; 125, **12p**; 220 **13p**; 470, **20p**; 680 **34p**; 1000 **27p**; 1500, **31p**; 2200 **36p**; 3300 **74p**; 4700 **79p**.

TAG-END TYPE: **450V**: 100µF **65p**; **70V**: 4700, **245p**; **64V**: 3300 **198p**; 2200 **139p**; **50V**: 3300 **154p**; 2200 **110p**; **40V**: 4700 **160p**; **25V**: 10,000 **320p**; 15,000 **345p**.

POLYESTER CAPACITORS: **Axial Lead Type**
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n, **38p**; 1µF **42p**; 1µ5 **45p**; 2µ2 **48p**; 4µ7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS Pcb
Type Miniature poly. Capacitors

250V
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 12n, 15n **7p**
18n, 22n, 27n, 33n 39n, 47n **8p**
39n, 56n, 68n **10p**
82n, 100n **10p**

100V
100n, 120n **10p**
150n, 180n **11p**
220n, 270n **14p**
330n, 390n **20p**
470n, 560n **26p**
680n **30p**
1uF **34p**
2u2 **50p**

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

FEED-THROUGH CAPACITORS
1000pF/450V **8p**

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0-22, 0-33 **15p**; 0-47, 0-68, 1-0, 1.5 **16p**; 2.2, 3-3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8. 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **26p**; 33, 47 **35p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & Lin.
500Ω, 1KΩ & 2KΩ (Linear only) Single Gang **29p**
5KΩ-2MΩ Single Gang Log & Lin. **29p**
5KN-2MΩ Single Gang D/P Switch **78p**
5KΩ-2MΩ Double Gang **89p**

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V**: 470nf **12p**.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **110p**
Self Stick Graduated Bezel **40p**

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF; 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**

PRESET POTENTIOMETERS
0.1W 50Ω 5MΩ Miniature Vertical & Horizontal **7p**
0-25W 100Ω 3-3MΩ horiz. larger **10p**
0-25W 200Ω 4-7MΩ vert. **10p**
Cermet, Precision, multiturn, 0.75W ¾in 100Ω-100KΩ **89p**

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SILVER MICA (Values in pF) 2, 3-3, 4.7 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**
z200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 **21p each**
1000, 1200, 1800, 2200 **30p each**
3300, 4700pF **60p each**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**

MINIATURE TYPE TRIMMERS
2-6pF, 2-10pF **22p**; 2-25pF, 5-56pF **30p**; 10-88pF **35p**

COMPRESSION TRIMMERS
3-40pF, 10-80pF **20p**; 20-250pF **28p**; 100-580pF **39p**; 400-1250pF **48p**

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RESISTORS Carbon Film High Stability. Low Noise. Miniature, Tolerance 5%.

	RANGE	VAL	1-99	100 ·
¼W	2.2Ω 4M7	E24	**2p**	**1p**
½W	2.2Ω 4M7	E12	**2p**	**1p**
1W	2.2Ω 1MΩ	E12	**5p**	**4p**
2% Metal Film 10Ω-1MΩ			**6p**	**4p**
1% Metal Film 0.5W 51Ω-1M			**8p**	**6p**

100 · price applies to Resistors of each value not mixed.

TRANSISTORS

AC125	35
AC126/7	35
AC128	30
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
ACY39/41	85
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF117/8	90
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	78
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	24
BC119	38
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC177/8	20
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	30

BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY30	68
BCY34	85
BCY35	50
BCY39/40	85
BCY42/43	14
BCY45	50
BCY58/59	35
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD124	115
BD131/32	48
BD133	60
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	85
BD696A	85
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BF224A	25

BF244B	29
BF245	30
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BF259	35
BF274	42
BF336/7	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
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BFX81	45
BFX84	26
BFX85/6	28
BFX87/8	28
BFY18	50
BFY50/1	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	90
BRY39	40
BSX20	20
BSX26/29	34
BSX78	45
BSY26	30
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ490	90
MJ491	175
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	65
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OC83/84	40
OC170/71	85
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TIP30C	58
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TIP31B	48
TIP31C	55
TIP32A	48
TIP32C	60
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	160
TIP35C	185
TIP36A	170
TIP36C	199
TIP41A	55
TIP41B	60
TIP42A	60
TIP42B	75
TIP120	90
TIP121/2	99
TIP141/2	120
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS46	45
TIS59/74	50
TIS90/91	30
UC734	65
VK1010	80
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2N1670	150
2N1671B	160
2N2160	295
2N2217	45
2N2218A	45
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2N2369A	18
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2N2907A	26
2N2926G	10
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2N3054	58
2N3055	48
2N3108	45
2N3252	46
2N3302	30
2N3441/2	140
2N3663	15
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2N3708/9	10
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2N3713	140
2N3771	179
2N3772	195
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2N3820	38
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2N3879	150
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2N3905/6	15
2N3906	17
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2N4058	10
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2N4064	115
2N4220	78
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2N4264	24
2N4286	15
2N4289	18
2N4314	68
2N4400	18
2N4427	80
2N4859	78
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	60
2N5135/6	20
2N5138	18
2N5172	18
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2N5180	45
2N5190/1	75
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2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	190
2N6027	32
2SA715	60
2SC495	70
2SC496	70
2SC1096	85
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170

2SC2091	85
2SC2314	85
2SC2166	165
2SC1679	190
2SC2335	225
2SC2612	225
2SD234	74
2SK45	90
3N128	112
3N140	112
40311	60
40313	130
40315	60
40316	95
40317/20	60
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	40
40361/2	50
40408	70
40411	285
40467A	130
40468	85
40594	105
40603	110
40636	175
40673	85

RF CHOKES
Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u **30p**
1mH, 1m5, 2m2, 4m7, 10mH **35p**
22m, 33m, 43m **60p**
100m **75p**

DIODES

AA119	15
BA100	15
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
IN5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

NOISE

Z5J **195p**

VARICAPS

BA102	50
BB105B	40
BB106	40
MVAM2	165
MVAM115	158

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

TRIACS

3A200V	54
3A400V	56
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	135
16A100V	103
16A400V	105
16A800V	220
25A500V	220
25A800V	295
T2800D	120

75 SERIES

75107	125
75108	350
75110	115
75150	125
75154	150
75182	115
75183	115
75188/9	62
75322	165
75450	95
75451/2	70
75454	225
75491/2	70

SCR Thyristors

5A/40V	32
5A400V	40
5A600V	48
8A300V	60
8A600V	90
12A100V	78
12A400V	95
12A800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2 **25**

COMPUTER ICs

1702	200
1802CP	700
2101-2	250
2114-450n	85
2114L-300n	87
2114L-200n	87
2118-3 250n	250
2147	425
2532-450n	450
2564	£20
2708	175
2716-5V	210
2732-450n	400
2764	£19
4027	240
4116-200n	80
4118-250	400
4164-200n	620
4315 Cmos	795
4334-3 = CMOS	
2114-3	325
5101-450	115
6116-3	580
6502CPU	399
6503	600
6504-250	550
6505	600
6520PIA	310
6522VIA	475
6530	1350
6532RRIOT	670
6545CRTC	1450
6551ACIA	785
6592PC	£20
6800	300
6802	400
6803	£12
6804	160
6805	670
6808	520
6809	999
6810	120
6820	175
6821	150
6840	420
6843	£14
6845	975
6847	850
6850	150
6852	255
6875	500
8080A	350
8085A	550
8116	oo
8123	125
81LS95	115
81LS96	115
81LS97	115
8202	£25
8212	170
8214	425
8216	70
8224	200
8228	250
8251	320
8253	799
8255	295
8257	800
8T26A	135
8T27	150
8T28A	115
8T31	350
8T95N	99
8T97N	99
AM26L531C	125

AM26L532A	125
AY-3-1015	300
AY-5-1013	300
AY-5-2376	600
FD1771	£18
FD1791	£28
FD1793	£30
FD1795	£30
FD1797	£35
IM6402	380
MC1488	55
MC1489	55
MC14411	695
MC14412	795
MM1702A	250
MM5 280D	695
RO-3-2513L	775
RO-3-2513U	600
SFF9634E	800
SFC71301	820
TMS2716-3V	875
TMS6011	365
ULN2003	100
Z80CPU 2.5	350p
Z80ACPU 4M	445
Z80PIO	290
Z80 DMA	999
Z80APIO	320
Z80CTC	300
Z80ACTC	325
Z80S10-1	£15
Z80AS10	£20
Z80Dart	550
Z80Adart	575

LINEAR ICs

555CMOS	80
702	75
709 14 pin	40
709C 8 pin	35
741 8 pin	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-0212	675
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-3-1270	840
AY-3-8500	390
AY-3-8910	600
AY-3-8912	625
AY-5-1224A	235
AY-5-1230	450
AY-5-1317A	630
AS-5-3500	350
AY-5-4007D	520
AY-5-8100	775
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70

CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3085	95
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
CA3160	95
CA3161	135
CA3162E	450
CA3189	295
HA1336W	240
ICL7106	750
ICL7107	975
ICL8038CC	300
ICL8211A	150
ICM7204	550
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7217A	790
ICM7224	785
ICM7555	80
ICM7556	00
LA3350	250
LA4031P	340
LA4032	295
LA4400	440
LC7130	340
LC7210	300
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LM10	395
LM301AP	26
LM308T	95
LM311	70
LM318N	200
LM319	215
LM324A	30
LM335Z	128
LM339	54
LM348	64
LM349	115
LM358	65
LM377	155
LM379	480
LM380	75
LM381N	145
LM382	125
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM394	320
LM725CN	325
LM733	75
LM1458	45
LM2917	195
LM3302	95
LM3900	50
LM3909N	85
LM3911	125t
LM3911	125
LM3914	210
LM3915	220
LM3916	220
LM13600	125
LS7220	280

M252AA	625
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3756	440
MC663	50
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	150
MC145106	695
MC1458	40
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	150
MC3340P	120
MC3360P	120
MC3401	65
MC3403	89
MC3405	150
MC4016	00
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM5387A	475
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	425
NE571	420
NE5534A	140
RC4136D	69
S566B	245
SAB3209	425
SAB3210	295
SAB3271	485
SAB4209	595
SG3402	295
SN76003N	350
SN76013	350
SN76018	148
SN76023ND	240
SN76033N	350
SN76115N	215
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TA7210	150
TA7130	160
TA7204	225
TA7205	220
TA7205A	225
TA7222	175
TA7310	175
TAA621AX1	295
TAA661A	190
TAA700	275

TAA900	00
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641 BX or BX11	350
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	290
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	250
TCA940	175
TCA965	120
TDA1004	290
TAD1008	310
TDA1022	325
TDA1024	105
TDA1034	350
TDA1490	290
TDA2002	325
TDA2020	320
TDA2030	320
TDB0791	420
TLO61CP	40
TLO62CP	60
TLO64CN	98
TLO71CP	30
TLO72CP	50
TLO74CN	100
TLO81CP	25
TLO82CP	45
TLO83CP	75
TLO84CN	95
TL170	50
TLO91CP	55
UAA1003-3	935
UAA170	170
UAA180	170
UAA2240	195
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
XR2206	300
XR2207	375
XR2216	675
XR2240	245
XR2266	750
ZN414	88
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	478
ZN429E	210
ZN1034E	200
ZN1040E	675

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	28
7407	28
7408	16
7409	16
7410	14
7411	20
7412	20
7413	24
7414	32
7416	25
7417	25
7420	16
7421	20
7422	20
7423	22
7425	28
7426	30
7427	27
7428	28
7430	16
7432	26
7433	27
7437	27
7438	27
7440	17
7441	68
7442	38
7443	90
7444	90
7445	65
7446	55
7447	50
7448	50
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	30
7473	30
7474	25
7475	40
7476	30
7480	48
7481	120
7482	70
7483	50
7484	80
7485	95
7486	26
7489	205
7490	28
7491	45
7492	30
7493	30
7494	34
7495	50
7496	45
7497	120
74100	85
74104	54
74105	55
74107	32
74109	35
74110	40
74111	55

74112	170
74116	88
74118	80
74119	90
74120	75
74121	30
74122	45
74123	50
74125	42
74126	40
74128	42
74132	48
74136	35
74141	70
74142	190
74143	250
74144	250
74145	70
74147	99
74148	75
74150	80
74151	45
74153	45
74154	75
74155	75
74156	75
74157	45
74159	99
74160	60
74161	60
74162	62
74163	64
74164	64
74165	62
74166	65
74167	185
74170	168
74172	290
74173	65
74174	72
74175	72
74176	55
74177	75
74178	95
74179	68
74180	65
74181	140
74182	75
74184	99
74185	99
74186	470
74188	290
74190	70
74191	70
74188	290
74190	70
74191	70
74192	70
74193	65
74194	75
74195	65
74196	65
74197	65
74198	99
74199	99
74221	80
74246	150
74247	150
74248	150
74249	150
74251	80
74259	195
74265	65
74273	195
74276	150
74278	160

74279	90
74283	90
74284	199
74285	199
74290	105
74293	125
74297	236
74298	100
74351	
74365	
74366	55
74367	55
74368	55
74390	99
74393	99
74490	120

74L

74L00	68
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S

74S00	38
S04	40
S132	110
S138	180
S158	195
S188	210
S189	158
S194	320
S195	795
S201	320
S225	510
S241	390
S262	850
S287	325
S288	210
S289	195
S301	00
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS

LS00	12
LS01	13
LS02	14
LS03	14
LS04	15
LS05	15
LS06	15
LS08	15
LS09	15
LS10	15
LS11	15
LS12	15
LS13	30
LS14	48
LS15	15
LS20	15
LS21	15

LS22	15
LS26	18
LS27	15
LS28	20
LS30	18
LS32	15
LS33	16
LS37	16
LS38	16
LS40	16
LS42	35
LS47	40
LS48	80
LS49	60
LS51	15
LS54	15
LS55	30
LS63	150
LS73	25
LS74	25
LS75	28
LS76	20
LS78	24
LS83	50
LS85	70
LS86	38
LS90	35
LS91	80
LS92	36
LS93	36
LS95	45
LS96	120
LS107	43
LS109	30
LS112	30
LS113	40
LS114	35
LS122	44
LS123	55
LS124	105
LS125	30
LS126	30
LS132	45
LS133	35
LS136	28
LS138	35
LS139	38
LS145	75
LS147	199
LS148	99
LS151	39
LS153	39
LS155	39
LS156	39
LS157	35
LS158	36
LS160	41
LS161	41
LS162	41
LS163	41
LS164	48
LS165	145
LS166	85
LS168	85
LS170	170
LS170	170
LS173	72
LS174	72
LS175	58
LS181	130
LS183	275
LS190	58
LS191	58
LS192	58
LS193	65
LS194	40

LS195	40
LS197	85
LS200	345
LS202	345
LS221	60
LS240	96
LS241	96
LS242	85
LS243	85
LS244	80
LS245	118
LS247	40
LS248	65
LS249	68
LS251	40
LS253	40
LS257	48
LS258	40
LS259	85
LS260	21
LS266	25
LS273	90
LS275	290
LS279	88
LS280	250
LS283	45
LS290	57
LS293	46
LS295	215
LS298	130
LS299	420
LS300	175
LS320	270
LS323	270
LS324	200
LS325	320
LS327	315
LS347	150
LS348	190
LS352	185
LS353	185
LS362	00
LS363	150
LS364	150
LS365	37
LS366	37
LS367	37
LS368	90
LS373	75
LS374	75
LS375	48
LS377	90
LS378	69
LS379	65
Ls384	395
LS385	378
LS390	62
LS393	60
LS395	199
LS396	190
LS398	275
LS399	220
LS445	140
LS447	195
LS471	620
LS490	245
LS541	135
LS571	620
LS640	225
LS641	225
LS645	210
LS668	175
LS669	150
LS670	175
LS673	550
LS674	750

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**.
(SPDT) 4 way **190p**.

ROTARY SWITCHES: (Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

ROTARY: (Mak-a-switch) Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 way **56p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

DIL PLUGS

14pin	44p
16pin	49p
24pin	88p
40pin	250p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250	375p	595p

Ribbon Cable

	ft
10 way	20p
20 way	40p
24 way	50p

AMPHENOL PLUGS

IEEE (24 way)	575p
Centronic parallel (36 way)	550p

VEROBOARD 0.1in

	clad	plain
2½ × 3¼"	73p	52p
2½ × 5"	83p	–
3¾ × 3¾"	83p	–
3¾ × 5"	95p	79p
3¾ × 17"	326p	211p
4¾ × 17"	426p	–
Pkt. of 100 pins	50p	
Spot face cutter	118p	
Pin insertion tool	162p	

VQ Board	150p
DIP Board	330p
Vero Strip	144p

PROTO DECs

Veroblock	375p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	785p
Superstrip SS2	1350p

VERO WIRING PEN + Spool **310p**
Spare Spool **75p**
Combs **6p**

DALO ETCH RESIST PEN + Spare tip **90p**

FERRIC CHLORIDE 1 lb bag Anhydrous **195p + 50p P&P**

ULTRASONIC TRANSDUCER 40KHz **395p pr**

COPPER CLAD BOARDS

	Fibre glass Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	90p	110p	95p
6" × 12"	150p	195p	

DIL SOCKETS (TEXAS)

	Low Prof.	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	22p	60p
22pin	25p	70p
24pin	25p	70p
28pin	28p	80p
36pin	–	109p
40pin	30p	99p

EDGE CONNECTORS: (Double type)

	.1	.156
2 × 10 way	–	135p
2 × 15 way	–	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 25 way	225p	220p
2 × 30 way	245p	–
2 × 36 way	295p	–
2 × 40 way	315p	–
2 × 43 way	395p	–
2 × 50 way	55p	–

D CONNECTORS (Cannon type)

Pins	Plugs	Sockets	Covers
9way	95p	125p	145p
15way	135p	198p	150p
25way	170p	250p	130p
37way	290p	398p	185p

Soldercon Pins
100 pins **70p**
500 pins **325p**

PLUGS & SOCKETS

	Plug	Socket	In-line
JACK			
2.5mm (plastic)	8p	–	10p
Metal	15p	8p	16p
3.5mm (plastic)	10p	15p	12p
Metal	16p	10p	18p
¼in Mono			
Plastic	15p	20p	15p
Metal	36p	14p	30p
¼in Stereo			
Plastic	22p	24p	22p
Metal	36p	20p	39p
DIN			
2 pin	8p	6p	14p
3 pin	13p	10p	15p
4 pin	16p	12p	15p
5 pin	13p	12p	15p
BANANA			
1mm	9p	9p	–
2mm	13p	13p	–
3mm (wander)	11p	11p	–
4mm	13p	14p	–
CO-AXIAL (TV)			
Plastic	10p	16p	8p
Metal	19p	20p	40p

UHF Connectors (50Ω-CB)
plug PL259 **40p**; Reducer **14p**;
Socket SO239 Round Chassis **40p**
Socket SO239 Square Panel **38p**

BULGIN OCTAL 250V-6A/pin
Plug P551 **199p**; Socket **68p**

IEC 3 pin 250V/6A

Plug, chassis mounting	40p
Socket, free hanging	95p
Socket, with 2 metre lead	150p

ZERO INSERTION FORCE DIL SOCKETS
24 way **650p**
28 way **820p**; 40 way **975p**

PANEL METERS

FSD 60x46x35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
495p each

RELAYS

REED, Encapsulated, Single Pole, 5W Normally Open, 200mA, 50V DC.

RL12	700Ω 6V to 9V	120p
RL13	1KΩ 9V to 12V	120p
RL14	1K7Ω 12V to 18V	120p
RL15	3KΩ 18V to 30V	135p

Single Pole, Change Over

RL16	1KΩ 4V to 10V	295p
RL17	1KΩ 9V to 12V	295p

Double Pole, Normally Open

RL18	350Ω 9V to 12V	200p

Miniature, enclosed, PCB mount. Our RL6 series.
S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W **210p**
D.P.C.O.
43Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W **218p**
RL6-111 170Ω coil, 8V-14V; 250V AC 5A. **220p**
RL6-114 740Ω coil, 17V5-29V 250V 5A AC. **222p**

CONTINENTAL Cradle Type Relays. Miniature Plug-in relays. 110V DC; 12V AC. 2A/DC; 2.5A AC 30W/100VA.
2 pole c/over 185Ω; 6V-18V. RL201 **180p**
2 pole c/over 13V to 35V; 700Ω; RL202 **180p**
4 pole c/over 9V to 18V; 185Ω. RL211 **220p**
High Power "Heavy Duty" PCB Mounting, Cradle type.
S.P.C.O. Power Gain 1:8000 380V AC/16A; 3.5K VA. 8 to 19V; 190M **295p**

PIEZO TRANSDUCERS
Type PB-2720 **75p**

BUZZERS, miniature, solid-state 6V; 9V & 12V **70p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω.
2in, 3¼in, 2½in, 3in **80p**
2½in 40Ω, 64Ω or 80Ω **80p**

GAS & SMOKE DETECTORS
For the detection of combustible and Toxic Gases like: Propane, Butane, Methane, Ammonia, Carbon Monoxide, Sulphur and Organic solvents vapours like Alcohol, Benzene, etc. Ideal for use in Boats, Caravans etc.
Type: TGS812 & 813 **525p**
Socket for above **40p**

ASTEC UHF MODULATORS
Standard 6MHz **280p**
Wideband 8MHz **425p**

ETI Autoranging Digital Capacitance Meter. All parts available.

CRYSTALS

32.768KHz	150
100KHz	270
200KHz	295
455KHz	370
1MHz	295
1.008M	290
1.28MHz	392
1.6MHz	395
1.8MHz	395
1.8432M	220
2.0MHz	240
2.4576M	220
3.278M	220
3.5794M	150
3.6864M	300
4.0MHz	200
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	120
5.0MHz	200
5.185MHz	300
5.24288M	390
6.144MHz	240
6.5536MHz	200
7.168MHz	250
7.68MHz	200
8.0MHz	200
8.86723M	200
9.00MHz	200
10.0MHz	200
10.24MHz	200
10.7	220
12.0MHz	290
14.31814M	320
16.0MHz	250
18.0MHz	240
18.432M	240
19.968MHz	325
24.0MHz	200
26.69M	290
27.648M	330
27.145M	240
38.6667M	290
48.0MHz	270
100.0MHz	375
116.0MHz	300

TRANSFORMERS: Prim. 240V

6-0-6V; 9-0-9V; 12-0-12V 100mA **98p**
pcb mounting, Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **200p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **270p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **220p**
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **330p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **440p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

	+ve			-ve	
1A	**TO3** metal case				
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p		7915	220p
18V	7818	145p			–
1A	**TO220** Plastic Casing				
5V	7805	45p		7905	55p
12V	7812	50p		7908	70p
15V	7815	50p		7912	55p
18V	7818	50p		7915	55p
24V	7824	50p		7918	55p
				7924	70p
100mA	**TO92** Plastic Casing				
5V	78L05	30p		79L05	60p
6V	78L62	30p			–
8V	78L82	30p			–
12V	78L12	30p		79L12	60p
15V	78L15	30p		79L15	60p

CA3085	95p
LM300H	170p
LM304H	170p
LM305H	140p
LM309KP	99p
LM309K	135p
LM317K	350p
LM317H	280p
LM317T	125p
LM323K	500p
LM325N	240p
LM326N	240p
LM723	35p
TAA550	50p
TBA625B	75p
TDA1412	150p
78HO5 + 5V/5A	550p
78HG +5V to +25V 5A	599p
79HG-2.25V to 24V 5A	785p

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	Plug	Socket
PCB Pins	200p	245p
RT. angle	210p	275p

We stock many more Plugs, Sockets and Jumper Leads.

25way 'D' CONNECTOR Jumper Lead Cable Assembly

18" long, Single End, Male	660p
18" long, Single End, Female	670p
36" long, Double Ended, M/M	1326p
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4000	14	4073	20	4532	110
4001	14	4075	20	4534	500
4002	14	4076	60	4536	295
4006	66	4077	26	4538	115
4007	18	4078	26	4539	115
4008	62	4081	26	4541	140
4009	35	4082	21	4543	135
4010	40	4085	65	4544	150
4011	15	4086	70	4549	395
4012	18	4089	140	4553	299
4013	34	4093	43	4554	190
4014	75	4094	168	4555	50
4015	66	4095	90	4556	55
4016	32	4096	90	4557	320
4017	48	4097	320	4558	120
4018	68	4098	88	4559	395
4019	42	4099	95	4560	180
4020	61	4160	95	4561	104
4021	70	4161	99	4562	495
4022	66	4162	99	4566	175
4023	20	4163	99	4568	250
4024	45	4174	99	4569	175
4025	19	4175	105	4572	36
4026	130	4192	00	4580	460
4027	38	4194	105	4581	250
4028	58	4408	790	4582	99
4029	77	4409	790	4583	99
4030	50	4410	725	4584	48
4031	170	4411	695	4585	99
4032	125	4412	800	4597	330
4033	165	4415	480	4598	290
4034	195	4419	280	4599	595
4035	95	4422	770	40097	88
4036	275	4428	00	40098	193
4037	115	4433	770	40100	215
4038	110	4435	850	40101	130
4039	290	4440	999	40102	180
4040	59	4450	350	40103	175
4041	78	4451	350	40104	95
4042	60	4490	350	40105	115
4043	70	4500	675	40106	75
4044	65	4501	28	40107	60
4045	170	4502	90	40108	450
4046	75	4503	50	40109	100
4047	75	4504	105	40110	300
4048	55	4506	65	40114	240
4049	30	4507	40	40161	194
4050	30	4508	265	40163	90
4051	78	4510	68	40174	95
4052	78	4511	68	40175	00
4053	78	4512	75	40181	220
4054	125	4513	199	40182	90
4055	125	4514	195	40192	90
4056	120	4515	198	40193	99
4057	1915	4516	75	40194	90
4059	480	4517	415	40257	195
4060	90	4518	42		
4061	1225	4519	29		
4062	995	4520	78		
4063	99	4521	200		
4066	36	4522	125		
4067	399	4526	95		
4068	22	4527	115		
4069	20	4528	80		
4070	26	4529	150		
4071	20	4530	90		
4072	20	4531	130		

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45

OPTO ELECTRONICS

LEDs with Clips

TIL209 Red	13
TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow or Amber	18
0.2" Bi colour Red/Green	65p
Green/Yellow	78p
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Square LEDs, Red, Green, Yellow	30
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	91
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH. Red 10 segments	225

ISOLATORS

IL74	55
TIL111/2/4	90
4N33 Photo Darlington	138

7 Segment Displays

TIL307	675
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TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
DL747 .6" CA	180
.8" Orange CA	250
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3"±1 Red CA	150
.3"±1 Green CA	150
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Designed by Watford Electronics, this extremely versatile and economical Expansion System as published in E.T.I., starting from December 1981 issue, offers a low cost flexible expansion system for: ZX81, UK101, SUPERBOARD, Acorn ATOM, PET, TANGERINE, TRS80, VIC 20, etc.
The Motherboard (interfaces with the Computer) has capability to accept up to five daughter Cards and can be paralleled for even more daughter cards.
All PC Boards are of Computer grade and are supplied in Kit form.
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1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

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Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

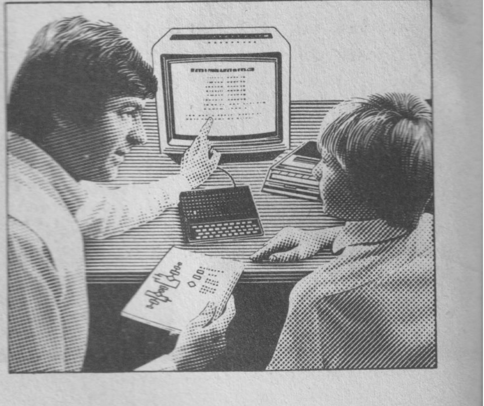
The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80'

New, improved specification
- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



uter-

Available now- the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

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EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item price £	Total £
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	16K-BYTE RAM pack.	18	49.95	
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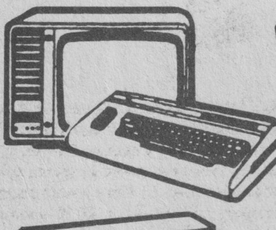

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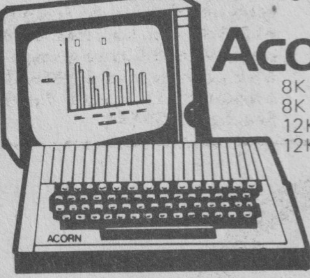

Acorn Atom

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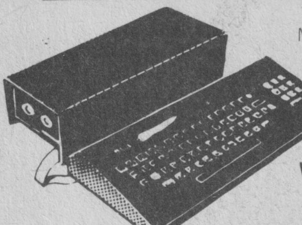

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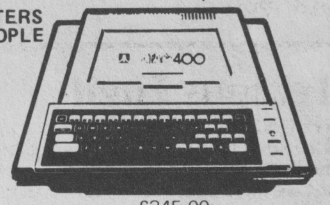

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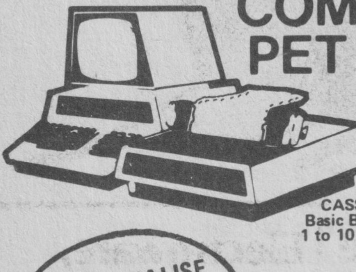

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Package B

ALTOS MULTI-USER HARD DISK SYSTEM

1 x ALTOS 8000/10 Computer with 10 Mbyte Hard Disk
208Kbyte Memory (4 users)
500Kbyte Floppy Disk Drive
2 x TVI 912C VDU's
1 x OKI Microline 83A Printer

SEC BUSINESS SYSTEMS SUPPLY A WIDE RANGE OF EASY-TO-OPERATE SYSTEMS AND PROGRAMMES TO MEET ALL OF TODAYS BUSINESS NEEDS + FULL RANGE OF COMPUTER RELATED PRODUCTS + LEASING AGREEMENTS + FULL AFTER SALES SERVICE

ALL PERSONAL COMPUTER ENQUIRIES:– Contact Paul Brown or Sam Wright on Hastings (0424) 437875 (Formerly Castle Electronics)

FOR ALL BUSINESS SYSTEMS ENQUIRIES:– Phone Nick Rosenberg on Hastings (0424) 426844

SEC *The Complete Computer Service!*

15 CASTLE STREET, HASTINGS, EAST SUSSEX TN34 3DY **DEPT. ET4**

DIGEST

ETI PRICE DECREASE

Readers will have no doubt noticed (painfully!) the cover price increase on this issue of ETI. We apologise for this, but are happy to say it is ONLY FOR THIS ISSUE and the price returns to 75p with the May issue.

The one-month jump was made necessary by the sheer size of this special issue. We hope you will agree it is worth it. If you could see the price of paper these days...(moan, moan).

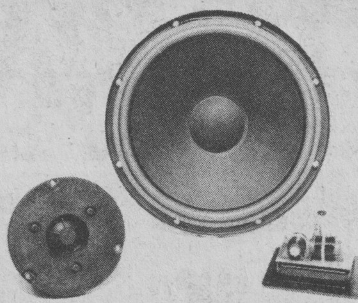
Thank you for sticking with us through thick and thin... (and 10p!)

Tempus Fugit

It's felt a little uncomfortable working in the ETI office this month; must be something to do with the sackcloth and ashes we're wearing. During the last few issues several of our reviews have featured Casio products, but we have consistently failed to credit the company which lent us the review models. The kindly folk in question are Tempus of 38 Burleigh Street, Cambridge CB1 1DG and we'd like to thank them for all the help they've been giving us. Tempus are leading Casio specialists and if there's something from Casio you're having problems obtaining, they will doubtless be as nice to customers as they are to us.

Sun-Day Driving

A Volkswagon Dasher car is presently being tested carrying a roof-rack of AEG-Telefunken solar modules which convert solar energy directly into electric current. The small 160 W 'solar power plant' of the test car complements the dynamo and charges the battery. This means that fuel consumption can be reduced by approximately five percent. As yet the cost of manufacturing these solar panels makes them uneconomical to use, but with the rising prices of fuel, it is foreseeable that low-priced solar generators will enter the market. Not only that, future car generations will make increased use of electricity, for example with automatic start-stop devices and pollution-free electrical energy for air conditioning in cars in warm countries. Great idea — but where will you put the luggage?



Tweeters That Go Cheap

Well, not just the tweeters, in fact. Mullard have a 40 W speaker system consisting of an 8" woofer as well as a high-power textile dome tweeter. They form part of a new low-price, two-way, self-build audio kit (whew!) being marketed by BK Electronics. The BK Electronics crossover unit have been combined with spring-loaded terminals and recessed mounting panel. The complete system, when built into the 23 litre enclosure, is capable of handling 40 W comfortably. All this for the small outlay of £13.90 plus VAT and £1.50 carriage per kit! Get yours now from BK Electronics Ltd, 37 Whitehouse Meadows, Eastwood, Leigh-On-Sea, Essex SS9 5TY.

Heading For The Top

Headphones seem to be getting lighter and smaller these days, so Sennheiser, that well-known manufacturer of headphones, has decided to launch a pair of their own lightweight 'phones. The new model HD40 is soon to be released in the UK and weighs only 60 grammes with extremely light contact pressure. They can be supplied with either a three or seven metre lead, the seven metre variety incorporating a volume control in the lead so that you don't have to march all that way back to the amp if it's too loud. Another feature is that each ear-piece can be revolved on the headband by 90 degrees if you have a funny shaped head or if you want to store them compactly (!). The Sennheiser HD40 will be launched in the UK with a suggested selling price, including VAT, of £16.55. For those of you interested in technical specs; frequency response is 22 to 18,000 Hz, impedance is 600 ohms, characteristic SPL is 90 dB and distortion factor $<1.2\%$.

Electroware, OK?

OK Machine and Tool (UK) Ltd have launched a new division aimed at providing the electronics user with a really wide range of electronic hardware. All the products in the range will be available to everyone involved in building electronic equipment — that includes engineers, students, teaching staff, laboratory technicians and, not least, the hobbyist. The 40-page catalogue contains various products selected from OK's bench tool range — plus some new items — and includes soldering irons, wire-wrapping kits, IC tools, PCBs, cases, enclosures, connectors, sockets and test instruments to name just a few. Electroware is distributed throughout the UK by leading electronic and computer stores. Catalogues are free, but send 30p for postage and packing. If you want any further information or one of their catalogues contact OK Machine & Tool (UK) Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA.

Lack of ZX81 memory giving you headaches..?

The Memotech 64K Memopak

The growth of interest in computer use caused by the introduction of the Sinclair ZX81 has made new and exciting demands on the ingenuity of electronic engineers. At Memotech we have focused our attention on the design of an inexpensive, reliable memory extension.

The Memopak is a 64K RAM pack which extends the memory of the ZX81 by a further 56K. Following the success of our 48K memory board the new memory extension is designed to be within the price range expected by Sinclair users. It plugs directly into the back of the ZX81 and does not inhibit the use of the printer or other add-on boards. There is no need for an additional power supply or for leads.

The Memopak together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts such basic commands as 10 DIM A(9000)

0-8K ...Sinclair ROM
8-16K...Memopak memory which can switch in or out in 4K blocks to leave space for memory mapping.
12-16K...Memopak memory which holds its contents during cassette loads and allows communication between programmes.
16-32K...This area can be used for basic programmes and assembly language routines.
32-64K...32K of RAM memory for basic variables and large arrays.

64K-£79

With the Memopak extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

MEMOTECH

Memotech Ltd
3 Collins Street
Oxford · OX4 1XL
Tel · 722102/3/4/5

Please debit my BARCLAYCARD/ACCESS* account number:

**Please delete whichever does not apply.*

Signature

Date

Please rush me:

	Quantity	Price	Total
64K RAM, Assembled		£68.69	
Stock Control Programme		£ 25.00	
Payroll Programme		£ 25.00	

NAME

ADDRESS

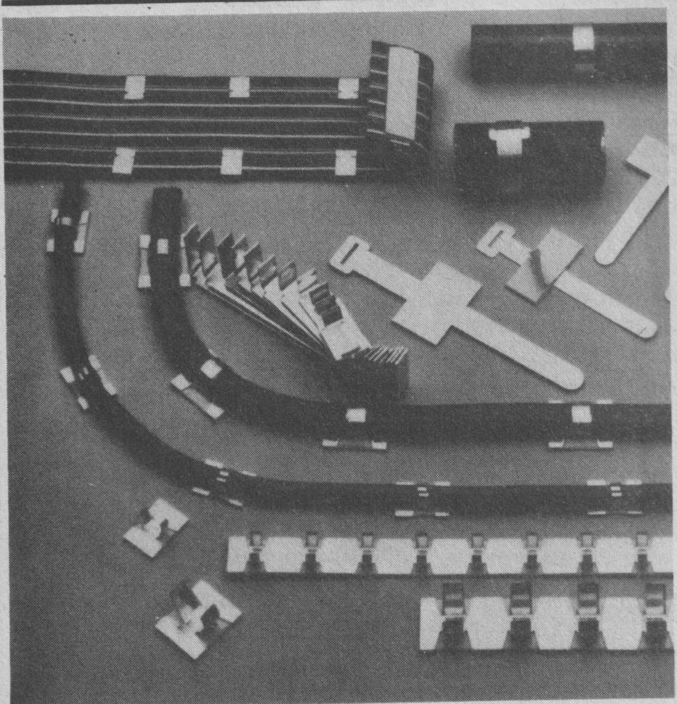
ETI

VAT @ 15%
Postage £2.00
TOTAL

To: Memotech Ltd., 3 Collins Street, Oxford, OX4 1XL Telephone (0865) 722102

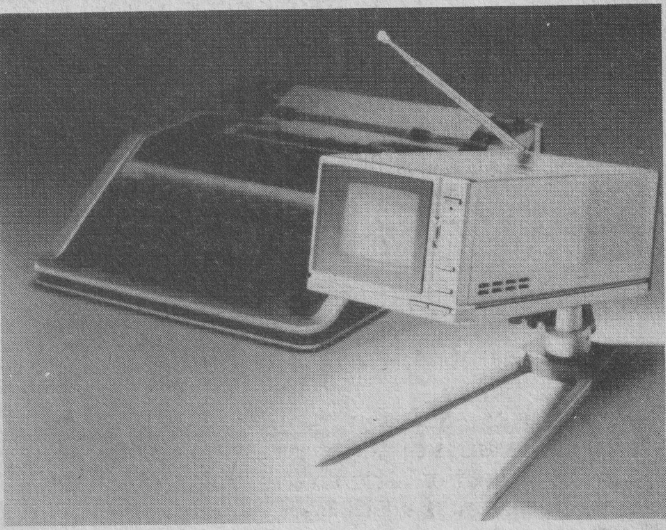
High-res Printing

New from Hi-Tek is the Facit 4542, a high-speed, high-resolution printer which combines a new type of 'Flexhammer' print-head with advanced microprocessor control to make it equally suited to text printing, label or bar code production, and graphics output. Using 260-character-per-second bidirectional two-colour printing and a 14 x 9 dot-matrix format, the 4542 can produce a virtually unlimited range of characters as well as different grey scales in graphics applications. In normal text-printing applications, the 4542 features proportional spacing, justified right-hand margin and an extensive set of up to 512 characters in 11 national repertoirs with red/black, elongated and underlining facilities. For label printing, a variable-size option is available which allows characters or bar codes to be generated in 95 different sizes from 2.52 mm up to 240 mm. Selection of size and position is easily controlled by software commands. In the graphics mode, scanning, semi-graphics and 10 levels of grey/red scale are available to illustrate reports with histograms, curves and diagrams, as well as generating half-tone illustrations in applications such as tomography, process monitoring and computer-aided design. The key to the versatility of the 4542 is the print-head, which consists of a set of nine stored-force flexible metal hammers mounted directly on a magnet armature. No adjustment or lubrication is necessary, wear is minimal, and a 'floating' mount means that the correct paper/print-head distance is always maintained irrespective of the paper thickness or number of copies. Further information is available from Hi-Tek Distribution Limited, Trafalgar Way, Bar Hill, Cambridge, CB3 8SQ.



Small And Beautiful

Hailed as 'the World's Smallest, Lightest and Lowest Power Consumption' television, the TH3-W3V from Matsushita certainly caught our editorial eye. Closer inspection revealed a colour TV set with a 3" colour picture tube, only 115 mm x 86 mm x 323.5 mm in size and 1.5 kg in weight. Power consumption is a mere 9.5 W and it operates on AC power, car batteries and on optionally available rechargeable batteries. Yet, despite its small size, it is equipped with video input/output terminals and operates as a colour monitor and a video tuner when connected to a video camera and a portable VTR, respectively. This 3" colour TV was launched on to the Japanese market in mid-December 1981 at the approximate price of £200. It is due for launch in the US in June this year and, hopefully, will be seen in this country shortly after. Further details will be supplied by National Panasonic (UK) Ltd, 300/313 Bath Road, Slough SL1 6JB.



Sticky Clips

Brandauer adhesive cable clips from Stotron provide an inexpensive method of fixing round or ribbon cables to clean, dry surfaces. The range can handle round cables from just a few millimeters up to 19 mm and flat ribbon cables from 13 mm to 75 mm can be accommodated by a selection of clips with widths in stages of 6 mm. The adhesive is instant acting and polyethylene pads provide high levels of insulation, where necessary. Further information is available from Stotron Ltd, Unit 1, Haywood Way, Ivyhouse Lane, Hastings, East Sussex.

Video Victory

Thorn EMI have just announced that agreements have been signed with Telefunken and JVC to form a holding company for the manufacture of video consumer electronics products in Europe. Thomson-Brandt was originally intended as a fourth partner, but this was not possible. However, the three other parties hope an opportunity will arise for Thomson-Brandt to join the venture.

Products manufactured by the joint venture will include VHS video cassette recorders, VHD video disc players and video cameras.

BT Bill Beater

Following the success of the Telcost TNA25 from the Ansafone Corporation, it was decided that a single line unit should be manufactured. The new machine offers a range of functions which are all designed to save money by monitoring telephone use. Ansafone's single line Telcost 1 has features including a 24-hour clock display, which instantly shows the cost of a call as soon as a user is connected with a number dialled. The unit also has a built-in printer which records details of the call including cost and number dialled. It also prints out the date, time, machine identification number and the duration of the call. Telcost 1 has a built-in memory which retains information even if the machine is disconnected from a power source. It also gives a special security midnight printout each night which frustrates any attempts to conceal the day's telephone costs by the destruction of the daily printout sheet. The machine is virtually tamper-proof as the printout will indicate if it has been disconnected from the line at any time or if any information parameters have been changed. The machine has provision for it to be reprogrammed at any time to enable the user to keep in line with British Telecom unit rate charges and the date, time and identification number can be changed for any reason if the machine is moved to a new location. This desk-top unit is no bigger than a telephone and for an investment of around £249 could help to cut out the abuse of telephones in both large and small companies.

Rapid Electronics

Tel: 0322 863494
Hillcroft House
Station Road
Eynsford, Kent DA4 0EJ

BARCLAYCARD VISA — Access Use Access here

LINEAR

		CA3162E	450	LM377	150	LM3900	50	NE566	150	TAD1024	125
★709	25	CA3189E	290	★LM380	65	LM3909	70	NE567	100	TLO71	45
★741	14	ICL7106	790	★LM381	100	LM3911	120	NE571	425	TLO72	75
748	35	ICL8038	320	LM382	120	★LM3914	200	RC4136	90	TLO84	90
AY-3-1270	840	ICM7555	80	★LM386	65	★LM3915	200	SN76018	150	XR2206	300
AY-3-8910	700	★LF351	40	LM387	120	LM13600	120	SN76477	150	ZN414	100
★AY-3-8912		LF353	85	LM393	100	MC1310	150	TBA641B11	250	ZN423	195
	625	LF356	90	★LM709	25	MC3302	150	TBA800	80	ZN424	135
CA3046	60	LM10	395	LM710	50	MC3340	135	TBA810	95	ZN425E	390
CA3080	65	★LM301A	25	LM725	350	NE515	270	TBA820	80	ZN426E	330
CA3089	215	LM311	70	LM733	75	NE529	225	TBA950	290	ZN427E	650
CA3090AQ	375	LM318	85	★LM741	14	NE531	150	TCA940	170	ZN428E	480
CA3130E	90	★LM324	40	LM747	75	NE544	185	TDA1004	300	ZN1034E	200
CA3140E	45	LM339	50	LM748	35	★NE555	16	TDA1008	320		
CA3160E	100	LM348	90	LM1458	40	★NE556	45	TDA1010	225		
CA3161E	140	LM358	50	LM2917	200	NE565	120	TDA1022	560		

CMOS

		★4017	43	4036	285	4055	115	4082	20	4502	70	4529	150
		4018	60	4039	295	4059	480	4085	65	4503	50	4532	95
4000	14	4019	35	4040	55	4060	85	4086	65	4507	38	4534	495
★4001	12	★4020	55	4041	75	4063	90	4089	140	4508	200	4538	110
4002	14	4021	65	4042	55	4066	35	★4093	33	4510	65	4543	110
4006	65	4022	70	4043	60	4067	395	4094	14	★4511	50	4549	380
4007	17	4023	18	4044	65	★4068	15	4095	90	4512	70	4553	295
4008	58	4034	40	4046	70	4069	18	4097	340	4514	180	4555	45
4009	30	4025	18	4047	70	4070	18	4098	85	4515	180	4556	48
4010	35	★4026	96	4048	55	4071	18	4099	95	4516	75	4559	390
★4011	13	4027	30	★4049	28	4072	18	40106	50	★4518	45	4560	180
4012	17	4028	55	4050	28	4073	20	40109	100	4520	70	4584	45
★4013	22	4029	75	4051	60	4075	20	40163	100	4521	200	4585	99
4014	60	4030	35	4052	70	4076	60	40173	100	4526	80	4724	140
4015	60	4031	170	4053	60	4077	25	40175	100	4527	90		
★4016	22	4034	170	4054	110	4081	18	40193	120	★4528	75		

TTL

		7413	24	7442	40	7480	45	74107	30	74155	60	74177	75
		7414	35	7444	85	7482	70	74109	32	74156	60	74179	65
7400	11	7416	25	7446	60	7483	50	74121	28	74157	43	74180	65
7401	11	7417	25	7447	48	7485	75	74122	45	74160	60	74181	135
7402	12	7420	15	7448	50	7486	25	74123	48	74161	60	74182	75
7403	14	7421	20	7450	16	7489	180	74125	40	74162	60	74190	70
7404	14	7422	20	7451	16	7490	28	74126	40	74163	60	74191	70
7405	17	7427	28	7453	16	7492	45	74132	40	74164	60	74192	70
7406	26	7428	28	7454	16	7492	40	74141	65	74165	60	74193	65
7407	26	7430	15	7460	16	7493	30	74165	65	74167	180	74194	70
7408	15	7432	25	7472	25	7494	35	74147	100	74170	165	74195	63
7409	16	7433	27	7473	28	7495	50	74148	75	74173	60	74196	63
7410	14	7438	27	7474	25	7496	45	74150	75	74174	65	74197	63
7411	20	7437	27	7475	38	7497	120	74153	45	74175	70	74198	95
7412	20	7440	17	7476	30	74100	80	74154	75	74176	55	74199	95

LS TTL

		LS21	15	LS76	20	LS125	30	LS161	42	LS221	60	LS365	38
		LS22	16	LS78	24	LS126	30	LS162	42	LS240	90	LS366	38
LS00	13	LS26	18	LS83	50	LS132	45	LS163	42	LS241	80	LS367	38
LS01	14	LS27	15	LS85	70	LS136	30	LS164	50	LS242	80	LS368	50
LS02	14	LS30	16	LS86	25	LS138	35	LS165	120	LS243	85	LS373	80
LS03	14	LS32	16	LS90	35	LS139	35	LS166	85	LS244	80	LS374	80
LS04	15	LS37	16	LS92	38	LS145	75	LS170	170	LS245	120	LS375	50
LS05	15	LS38	16	LS93	35	LS147	160	LS173	70	LS247	75	LS377	90
LS08	16	LS40	16	LS95	45	LS148	95	LS174	60	LS251	40	LS378	70
LS09	16	LS42	38	LS96	110	LS151	40	LS175	60	LS257	48	LS390	75
LS10	16	LS47	40	LS107	45	LS153	40	LS190	55	LS258	45	LS393	75
LS11	16	LS48	80	LS109	30	LS154	120	LS191	55	LS259	95	LS399	220
LS12	15	LS51	16	LS112	30	LS155	45	LS192	55	LS266	25	LS541	135
LS13	25	LS55	30	LS113	30	LS156	45	LS193	60	LS273	90	LS670	175
LS14	48	LS73	25	LS114	30	LS157	35	LS195	50	LS279	50		
LS15	15	LS74	25	LS122	42	LS158	36	LS196	60	LS283	45		
LS20	15	LS75	27	LS123	55	LS160	42	LS197	68	LS353	100		

TRANSISTORS

		BC157	10	BC558	10	BFX84	25	TIP30	45	★ZTX107	8	2N3054	55
		BC158	10	BCY70	18	BFX85	25	TIP30A	40	★ZTX108	8	2N3055	50
AC125	35	★BC159	8	BCY71	18	BFX86	28	TIP30B	50	ZTX109	12	2N3442	120
AC126	25	BC160	45	BCY72	18	BFX87	25	TIP30C	60	ZTX300	14	★2N3702	6
AC127	25	BC168C	10	BD115	80	BFX88	25	TIP31A	45	ZTX301	16	2N3703	9
★AC128	20	BC169C	10	BD131	35	BFY50	23	TIP31B	45	ZTX302	15	★2N3704	6
AC176	25	BC170	8	BD132	35	BFY51	23	TIP31C	55	ZTX304	17	2N3705	9
AC187	22	BC171	10	BD133	50	BFY52	23	TIP32A	45	ZTX341	30	2N3706	9
AC188	22	BC172	8	BD135	50	BFY53	32	TIP32B	55	ZTX500	15	2N3707	10
AD142	120	BC177	18	BD136	30	BFY55	32	TIP32C	60	ZTX501	15	2N3708	10
AD149	80	BC178	18	BD137	30	BFY56	32	TIP33A	50	ZTX502	15	2N3709	10
AD161	40	BC179	18	BD138	30	BRY39	40	TIP33C	75	ZTX503	18	2N3772	190
AD162	40	BC182	10	BD139	35	BSX20	20	TIP34A	60	ZTX504	25	2N3773	210
AF124	60	★BC182L	8	BD140	35	BSX29	35	TIP34C	85	2N697	20	★2N3819	15
AF126	50	BC183	10	BD204	110	BSY95A	25	TIP35A	160	2N698	40	2N3820	40
AF139	40	BC183L	10	BD206	110	BU205	160	TIP35C	180	2N706A	20	2N3823	65
AF186	70	BC184	10	BD222	85	BU206	200	TIP36A	170	2N708	20	2N3866	90
AF239	75	★BC184L	7	BF180	35	BU208	170	TIP36C	195	2N918	35	2N3903	10
BC107	10	BC212	10	BF182	35	MJ2955	99	TIP41A	60	2N1132	22	2N3904	10
BC107B	10	BC212L	10	BF184	25	MJE340	50	TIP42A	60	2N1613	30	★2N3905	6
★BC108	8	BC213	10	BF185	25	MJE520	65	TIP120	90	2N2218A	45	2N3906	10
BC108B	12	BC213L	10	BF194	12	MJE521	95	TIP121	90	2N2219A	25	2N4037	45
BC108C	12	BC214	10	BF195	12	MJE3055	70	TIP122	90	2N2221A	25	2N4058	10
★BC109	8	★BC214L	8	BF196	12	MPF102	40	TIP141	120	2N2222A	20	2N4060	10
BC109C	12	BC237	8	BF197	12	MPF104	40	TIP142	120	2N2368	25	2N4061	10
BC114	22	BC238	14	BF198	10	MPSA05	22	TIP147	120	2N2369	11	2N4062	10
BC115	22	BC308	15	BF199	18	MPSA06	25	TIP2955	60	2N2484	25	2N5457	36
BC117	22	BC327	14	BF200	30	MPSA12	30	TIP3055	55	2N2646	45	2N5458	36
BC119	35	BC328	14	★BF244B	18	MPSA55	30	TIS43	40	2N2904	20	2N5459	30
BC137	40	BC337	14	BF245	30	MPSA56	30	TIS44	45	2N2904A	20	2N5485	36
BC139	40	BC338	14	BF256B	45	MPSU05	55	TIS45	45	2N2905	22	2N5777	45
BC140	30	BC477	30	BF257	32	MPSU06	55	TIS90	30	2N2905A	22	2N6027	30
BC141	30	BC478	30	BF258	25	MPSU55	60	TIS91	30	2N2906	25	40360	40
BC142	25	BC479	30	BF259	35	MPSU56	60	★VN10KM		2N2906A	25	40361	50
BC143	25	BC517	40	BF337	40	TIP29	35		45	2N2907	25	40362	50
BC147	8	★BC547	7	BFR40	23	TIP29A	40	VN46AF	75	2N2907A	25	40408	70
BC148	8	BC548	10	BFR80	25	TIP29B	55	VN66AF	85	2N2926	9	40594	100
BC149	9	BC549	10	BFX29	25	TIP29C	60	VN88AF	95	2N3053	23		

DIODES

BY127	12	★1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
★1N4148	2	400mW zen.	6p

CABLES

20 metre pack single core connecting cable, ten different colours	65p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way ribbon	65p/m
20 way ribbon	120p/m

VERO

Verobloc **350p.**
Size 0.1 matrix

2.5 × 1″	22p
2.5 × 3.75″	75p
2.5 × 5″	85p
3.75 × 5″	95p
VQ Board	160p

Veropins per 100

Single sided	50p
Double sided	60p
Spot face cutter	105p

BOXES

Dimensions in inches. Aluminium.

3 × 2 × 1	70p	6 × 4 × 2	120p
4 × 3 × 1½	85p	6 × 4 × 3	150p
4 × 3 × 2	100p	8 × 6 × 2	180p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at reduced prices.

¼W 5% Resistor Kit. Contains 10 of each value from 4.7Ω to 1M (650 resistors) **480p.**

Ceramic Capacitor Kit. Contains 5 of each value from 22p to 0.01 (135 caps.) **370p.**

Polyester Capacitor Kit. Contains 5 of each value from 0.01 to 1uF (65 caps.) **575p each.**

Preset Kit. Contains 5 of each hor. Value from 100Ω to 1M (total 65 presets). **425p each.**

Nut and Bolt Kit. Total 300 items. **140p.**

25 6BA ¼″ bolts	25 4BA ¼″ bolts
25 6BA ½″ bolts	25 4BA ½″ bolts
50 6BA nuts	50 6BA nuts
50 6BA washers	50 6BA washers

SWITCHES

Submin. Toggle
SPST **55p** SPDT **60p** ★DPDT **50p**
Miniature toggle
SPDT 80p SPDT centre off **90p**
DPDT **90p** DPDT centre off **100p**
Standard toggle
SPST **35p** DPDT **48p**
★Miniature DPDT slide **12p**
★Push to make **12p** Push to break **22p**
Rotary type adjustable stop
1P12W 2P6W, 3P4W, 4P3W **all 55p each**
DIL switches
4 SPST **80p** 6 SPST **80p** 8 SPST **100p**

REGULATORS

Positive		Negative	
★78L05	25	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
★7805	45	★7905	45
★7812	45	★7912	45
7815	60	7915	60
LM309K	130	★LM323K	350
★LM317T	120	LM723	40

CAPACITORS

Polyester. Radial Leads. 250V 280 type.
0.01, 0.015, 0.022, 0.033, **6p;** 0.047, 0.068, 0.1, **7p;** 0.15, 0.22, **9p;** 0.33, 0.47, **13p;** 0.68, **20p;** 1u **23p.**

Electrolytic Radial or Axial leads.
0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V, **7p;** 22/25V, 47/25V, **8p;** 100/25V, **9p;** 220/25V, **14p;** 470/25V, **22p;** 1000/25V, **30p.**

Polyester. Siemens PCB.
1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, **7p;** 22n, 33n, 47n, 68n, **8p;** 100n, **9p;** 150n, **11p;** 220n, **13p;** 330n, **20p;** 470n, **26p;** 680n, **29p;** 1u, **33p;** 2u2, **50p.**

Tantalum bead.
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V **12p;** 2.2, 4.7, 10 @ 25V, **20p;** 15/16V **30p;** 22/16V, **27p;** 33/16V, **45p;** 47/6V, **27p;** 47/16V, **70p;** 68/6V, **40p;** 100/10V, **90p.**

Ceramic. 22p-0-01u. 50V. **3p each.**
Polystyrene. 5% tolerance.
10p-1000p **6p.** 1500-4700 **8p.** 6800p-0.012 **10p.**
Trimmers. Mullard 808 Series.
2-10pF **22p.** 2-22pF **30p.** 5.5-65pF **35p.**

PANEL METERS

Sixe 60 × 46 × 35mm.

0-50µA	0-500mA
0-100µA	0-1A
0-500µA	0-50V AC
0-1mA	VU
0-10mA	0-300V AC
0-50mA	0-25V
0-100mA	0-30V DC

450p each.

SOCKETS

★8 pin	7p
★14 pin	9p
★16 pin	10p
18 pin	15p
20 pin	18p
22 pin	20p
24 pin	22p
28 pin	26p
40 pin	32p

Soldercon pins **60p**/100

HARDWARE

PP3 Battery clips	6p
Red or black crocodile clips	6p
Black pointer control knob	15p
Pair Ultrasonics	350p
TO220 twisted vane heatsink	28p
20mm panel fuseholder	25p
4mm terminals (var. colours)	33p
TO18 transistor socket	15p
64mm 64 ohm speaker	70p
64mm 8 ohm speaker	70p

TRANSFORMERS

Please add carriage charges to our normal post charges

Miniature mains.
606V, 909V, 12012V all @ 100mA **100p each**

High quality, Split bobbin construction.

6VA	0-6, 0-6 @ 0.5A; 0-9, 0-9V @ 0.4A 0-12, 0-12V @ 0.3A. **220p each.**
12VA	0-6, 0-6 @ 1A; 0-9, 0-9V @ 1.2A; 0-12, 0-12 @ 0.5A; 0-15, 0-15V @ 0.4A **275p each** (plus 40p carriage).
24VA	0-6, 0-6V @ 1.5A; 0-9, 0-9V @ 1.2A; 0-12, 0-12V @ 1A; 0-15, 0-15V @ 0.8A; **330p each** (plus 60p carriage)
50VA	0-12, 0-12V @ 2A; 0-15, 0-15V @ 1.5A; **400p each** (plus 70p carriage)
100VA	0-30, 0-30V @ 1.6A **920p each** (plus 80p carriage).

POTENTIOMETERS

Rotary. Carbon track Log on Lin 5K-1M
Single **32p.** Stereo **85p each.**
Slide. 60mm travel single Log or Lin 5K-500K. **63p.**
Preset. Submin horiz. 100Ω-1M. **7p.**

RESISTORS

¼W 5% Carbon film E12 series. 4.7Ω-10M. **1p each**
½W 5% Carbon film E12 series 4.7Ω-4M7. **2p each**
¼W 1% Metal film. E24 series 10Ω-1M. **6p each.**

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Access Use Access here — BARCLAYCARD VISA

SOLDERING IRONS

Antex CX 17W Soldering Iron	420p
2.3mm and 4.7mm bits to suit	55p
CX 17W element	190p
Antex X25 25W Soldering Iron	440p
3.3mm and 4.7mm bits to suit	55p
X25 25W element	190p
Solder pump desoldering tool	480p
Spare nozzle for above	70p
10 metres 22 swg solder	100p

OPTO

★3mm red	8	★5mm red	8
★3mm green	12	★5mm green	12
★3mm yellow	12	★5mm yellow	12

Clips to suit **3p each**

Rectangular		TIL32	40
★red	12	TIL78	40
green	17	TIL111	60
yellow	17	ORP12	85

Seven Segment Displays

Com. cathode		Com. anode	
DL704 0.3″	95	DL707 0.3″	95
★FND500 0.5″	65	FND507 0.5″	90
TIL313 0.3″	105	TIL312 0.3″	105
TIL322 0.5″	115	TIL321 0.5″	115

All seven segment displays are supplied with connection details.
2N5777 **45** Dual Colour LED **60**

TRIACS + SCRS

SCRs		TRIACs	
C106D	30	400V 4A	60
400V 8A	70	400V 8A	70
400V 12A	99	400V 16A	105

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	★7p	★7p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	13p	13p	4mm	18p	17p

UHF (CB) Connectors
PL259 Plug **40p** Reducer **14p**
SO239 Square chassis socket **38p**
SO239S Round chassis socket **40p**

IEC 3 pin 250V/6A
Plug chassis mounting **38p**
Socket free hanging **60p**
Socket with 2m lead **120p**

PCB MATERIALS

Alfac PCB transfer sheets — please state type (e.g. DIL pads etc.)	45p
Dalo etch resist pen	100p
Fibre glass board 3.75″ × 8″	75p
Ferric Chloride 250ml bottle	100p

ORDERING INFO

All prices **exclude** VAT. Please add to total order. Please add 50p carriage on all orders under £10 in value. Send cash/cheque/PO or Access/Visa number with your order. Send SAE for discounts list (free with orders). Official orders welcome from colleges, schools etc. Export orders no VAT, please add carriage.

CRYSTALS

				5.0M	240	18.0M	240
				6.0M	200	18.432M	220
100KHz	290	2.4576M	220	6.144M	180	19.968M	300
200KHz	370	3.276M	240	7.00M	250	26.69M	300
1MHz	300	3.579M	120	8.0M	170	27.145M	240
1.008M	370	4.0M	150	10.0M	180	38.6667M	320
1.8432M	300	4.194M	150	12.0M	290	48.0M	220
2.0M	270	4.43M	125	16.0M	240	116M	300

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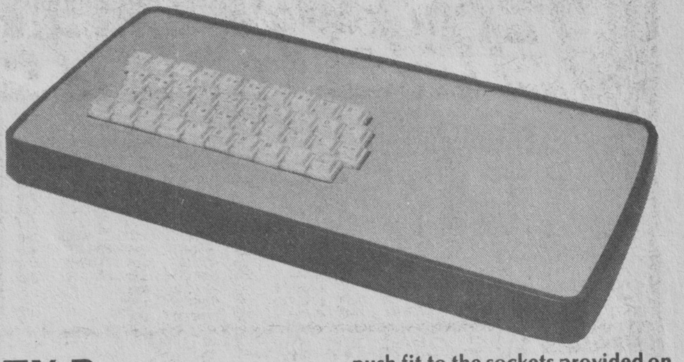
Grabbed By The Dooleys

Those tireless chappies down at Casio have taken time off from disguising BASIC computers and arcade games as pocket calculators and watches, and have turned their attention to the music scene. Although there is undoubtedly a market for top-flight organs and synthesisers amongst home musicians, many people will prefer something more modest — for financial reasons, because the living room is too small or because they can't figure out what all the knobs do. At the other end of the scale (sorry), the type of hand-held organ made notorious by Rolf Harris is a little too limiting. With the Casiotone 701, Casio have not just produced a solution to this problem but a radically new type of instrument.

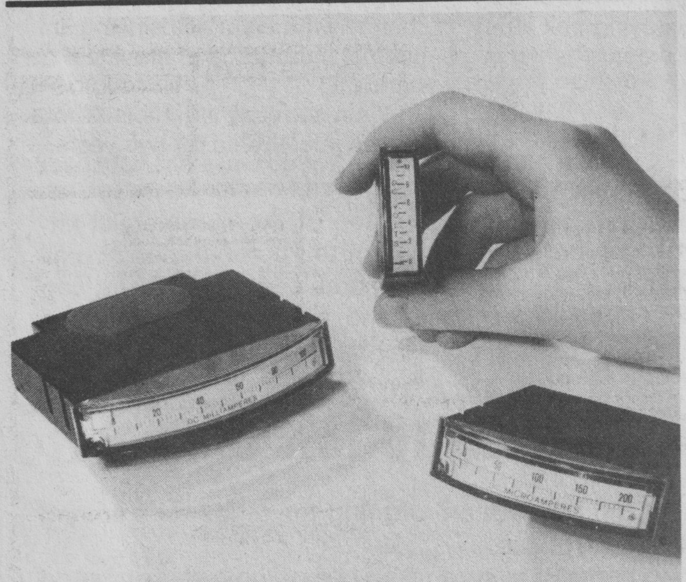
The CT-701 is not just a 61-key polyphonic (eight voice) mini-synthesiser, but also contains an on-board computer that acts as a built-in sequencer; among other things. You can play along with the built-in rhythm unit, store your own music in memory and play it back automatically, or just load the machine with a Casio music score and let it get on with things by itself. The latter function is quite extraordinary — Casio supply the music scores as bar codes and you read them into the machine using a light pen (like those at supermarket check-out desks). In melody guide mode you can even teach yourself to play the instrument, as LEDs above each key light up to tell you which note to play next.

Twenty preset sounds are available, such as pipe organ, flute, piano, oboe, bassoon etc, plus the synthesised drum sounds of the rhythm unit and the 'pneooum' sound so beloved by producers of disco records. Opinions of the preset sound quality vary from "beautiful" (Casio) through "very good" (an independent reviewer) to "too sharply filtered" (another independent reviewer). Since they can't agree and we haven't heard it (though, we're trying hard to get our mucky paws on one), you'll have to listen to one yourself before parting with any cash, but professional musicians seem to like it — the Dooleys use Casiotone mini-keyboards in their stage shows (fellow headbangers may not see this as a compliment). With so much packed into such a compact case (only slightly larger than the actual keyboard) and such a low price (about £500), Casio would certainly seem to have done it again.



ZX Revamp

For those of you who are serious ZX-81 owners (is there such an animal?) or would simply like to disguise the machine, there is a professional standard keyboard and enclosure now available from Protos Computer Systems. The keyboard is the first of a range of peripherals to make the computer suitable for more heavy-duty use. The 40-key Sinclair coded board uses top quality mechanical contact type key switches with relegendable tops. A steel mounting board holds the keys firmly in position and a high quality printed circuit board completes the board's electrical circuit. Connection to the Sinclair board is made by a flexible connector which is a push fit to the sockets provided on the ZX81. Access to the edge board connector is via a side port on the Protos enclosure and tape in/out, power and UHF connections are made through the rear. To fit the Protos entails removing the Sinclair board from the black ABS case it comes in and fixing it inside the Protos enclosure with four Phillips type screws. No soldering is required and all electrical connections are plug/socket connections provided either on the Sinclair or the Protos. Further details on this and other forthcoming peripherals can be obtained from Protos Computer Systems, Frome Computing, 20 Ashtree Road, Frome, Somerset BA11 2AS. Please enclose a large SAE with any enquiries.

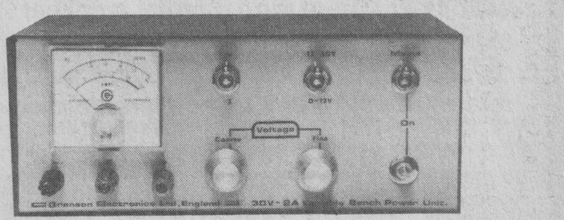


Thin Meters

Sifam Ltd of Torquay in Devon are to market a range of very thin edgewise meters manufactured by General Electric of the USA. There are three sizes in the range with case widths of 38 mm, 63 mm and 89 mm and the units are scaled for vertical or horizontal presentation. The special feature of this design is the extreme thinness; the smallest has an overall depth of face of only 13 mm and the two larger sizes of about 17 mm. The smallest model has a rear-access zero set and a simple spring-clip method of mounting. The two larger models have front access zero set at end of scale and a slide bracket form of mounting. They incorporate jewelled pivot movements with special high-torque magnets for reliable and accurate operation. The standard meters are available ex-stock from Sifam and have a maximum sensitivity of 50 microamperes. Scale markings can be produced to suit individual requirements. Further details of these and Sifam's own range of meters are available from: Sifam Limited, Woodland Road, Torquay, Devon TQ2 7AY.

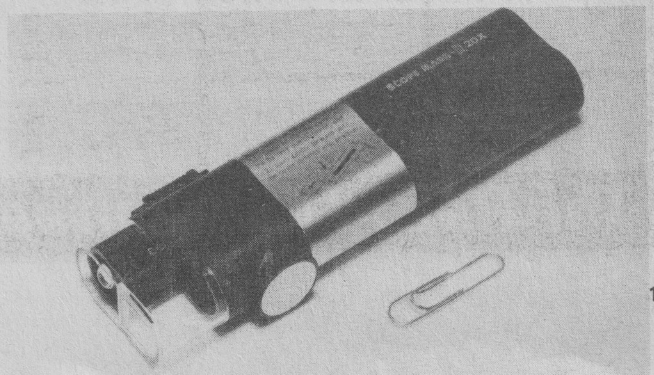
Power For Peanuts

Grenson Electronics, designers and manufacturers of power supplies for the Nuclear Research Industry have come up with a series of bench power units. The first unit in the series is priced at £59 and gives a variable stabilised output up to 30 V at 2 A in two ranges, has foldback re-entrant short circuit protection and current and voltage metering. This unit is also available in kit form at only £35 and further details are from Grenson Electronics Ltd, High March Road, Long March, Industrial Estate, Daventry, Northants NN11 4HQ.

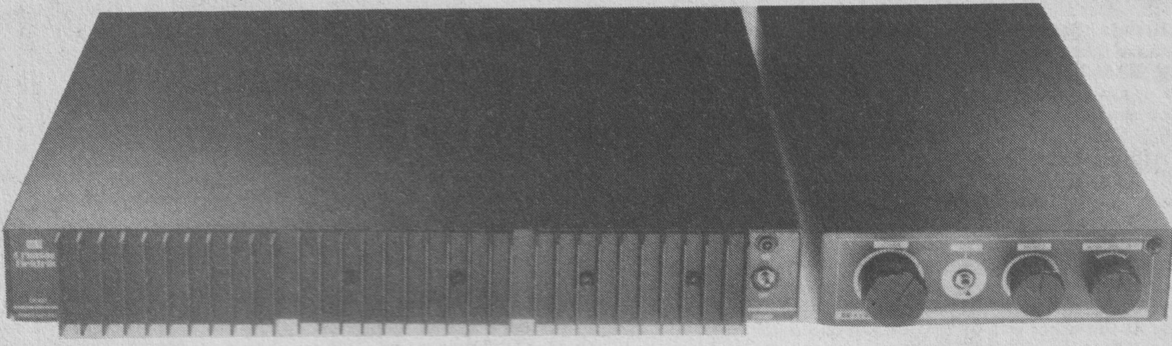


Miniature Magnification

New from Stotron Ltd is the Scope Mark III pocket microscope with stand. Priced at under £20 it is a useful tool for laboratories, schools, workshops, service engineers and the electronics, electrical, automotive, print and graphic trades, Uncle Tom Cobbley and all! It is 125 mm long, with 20x magnification and a graticule showing linear and angular measurements. Illumination is powered by standard 1V5 'pen-light' batteries and a micro-stand (with spring clips for sample slides) is available as an option so that the device can be used like a conventional microscope. Further details on this device are available from Stotron Ltd, Unit 1, Haywood Way, Ivy House Lane, Hastings, East Sussex.



New Products



HIFI STEREO AMPLIFIER KITS
From one of Britain's leading esoteric amplfier manufacturers comes an exciting new package of stereo amplifier kits, designed to offer all the advantages of true high fidelity but without the usual price penalty.
These new kits offer the choice of moving magnet or moving coil inputs, 40 or 100 watts per channel, in fact, everyhthing that made the previous models so popular is imcluded but with added style, easier construction and a full two year warranty.

The New Range Consists of
The CK 1010 Stereo Pre Amplifier
The CK 1404 WPC Power Amplifier
The CK 1100 WPC Power Amplifier

CK 1010
This kit contains all the necessary parts to build a complete pre-amp. The main PCB is ready assembled and tested therefore construction is simply a matter of point to point wiring and mechanical assembly of the connections and controls to the pre punched chassis.

The CK 1010 takes its DC supply from the CK 1040, 1100 or, if using a different power amplifier a PSK power supply kit. Inputs for disc, tuner and tape are provided and an optional add-on moving coil input can be fitted to extend its versatility. (MC2K)

CK 1040
This is a nominal 40 watt per channel power amplifier kit which features our dual power supply and the DC output for the CK 1010. All components such as heatsinks, wire and connectors are included and protection is provided from short circuit outputs.

CK 1100
Similar to the CK 1040 this model provides a nominal 100 watts per channel with extra heatsinking and thermal cutouts are provided as standard.

When correctly assembled these kits are guaranteed for two years.

"It would seem then that Crimson have maintained their position at the top of the commercial kit-build field. There is no oriental amplifier I know of that can better the sound of this combination overall at any price and only a few — such as the KA-1000 (500+) — are of comparable standard . . . I can say no more than that for £250 it (CK1010/MC2K/1100) is a bargain and one that becomes the reference point for kit amplifiers from now on."

ETI FEB 1982

SPECIAL INTRODUCTORY OFFER 10-15% OFF!

As a special incentive to buy our new range of D.I.Y. Hifi Kits, we are offering the range for a limited period at silly discount prices
The offer closes on March 31st, with prices this low, demand is sure to be heavy, so order now and avoid delays at the same time save £££'s

CK 1010 — RRP £90.00 .... **SPECIAL PRICE £79.20**
CK 1040 — RRP £119.00 .... **SPECIAL PRICE £105.80**
CK 1100 — RRP £149.00 .... **SPECIAL PRICE £130.80**
MC2K — RRP £25.00 .... **SPECIAL PRICE £22.50**
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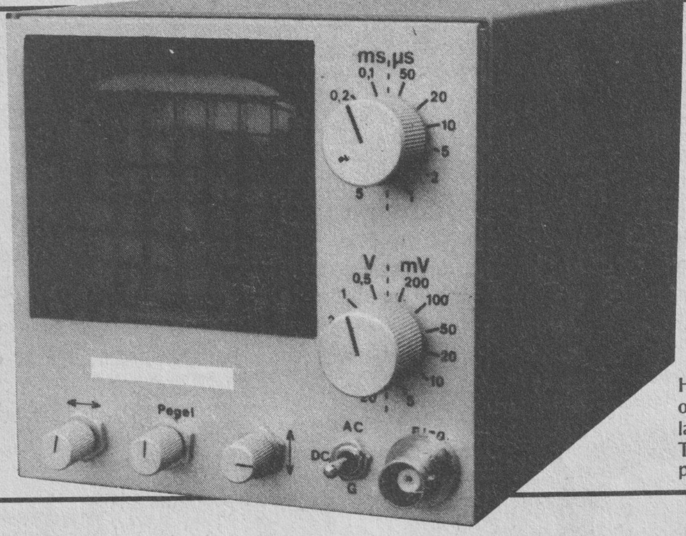
NEXT MONTH

electronics today INTERNATIONAL



How would you like a 10 MHz oscilloscope about the size of a large lunchbox? Can't afford one? Then build this one — it's the main project in ETI next month.

SLOT CAR CONTROLLER

Let's not beat about the bush. Slot cars are fun. If you're as keen on slot cars and electronics as we are, you'll be equally appalled at the crude control systems provided in the basic sets. Naturally we decided something should be done about the situation and came up with this project. You can have controlled acceleration with overshoot, dynamic braking, 'electronic' fuel tanks — and all from quite a simple circuit. There'll also be some advice on how to tune your cars to get the ultimate in performance from them. A must to read for kids of all ages.

COLUMN LOUDSPEAKER DESIGN

Now this is good stuff. One of the bugbears of public address systems is acoustic feedback, which can be largely overcome by the use of a highly directional sound source. This directs the sound into the audience, where it's needed, and away from the microphone, where it isn't. This article describes the design of a novel column loudspeaker design that is cheap and highly effective.

ROBOT CONTROLLER PART 3

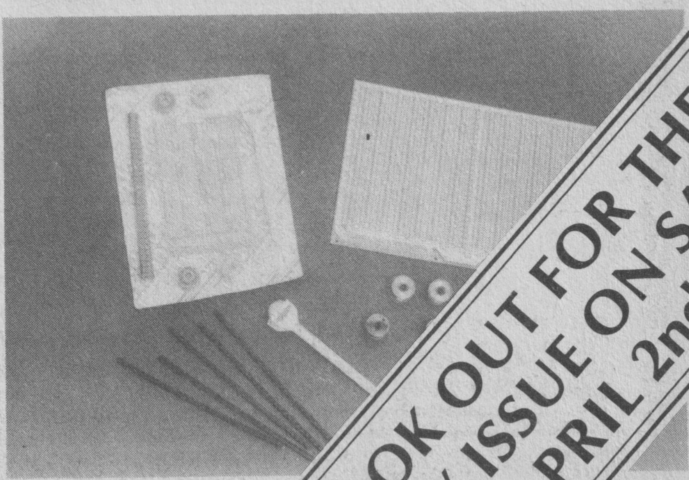
In next month's ETI we continue this series with the construction information for this month's analogue pulse width modulation controller, plus full details and a PCB for a dual digital PWM controller. This will not only be of interest to roboticists but to anyone who needs to control the speed of DC motors.

DVMEG

Any scholars out there will know that D is Roman for 500. Since V stands for volts, it will come as no surprise that this project generates 500 V to enable the leakage current through insulation to be tested using the built-in meter. In effect it is a high-voltage resistance meter for measuring values above about 1M0 — hence the last part of the name. We don't just throw these things together, you know!

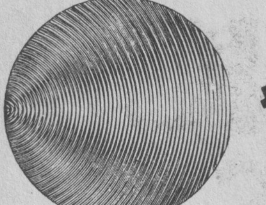
BREADBOARDING SYSTEMS

There appears to have been a veritable explosion in the number of breadboarding and prototyping systems available to industry and the hobbyist; next month we'll be taking a look at some of them. Both solderwrap and insulation displacement techniques will be examined and we'll have an exclusive first review of a major new development from a leading manufacturer. Not to be missed!



LOOK OUT FOR THE MAY ISSUE ON SALE APRIL 2nd

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.



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A SOUND CHOICE

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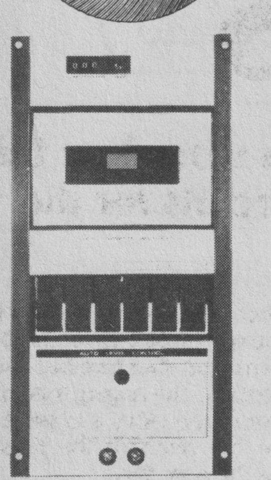
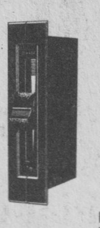


6 piano type keys

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

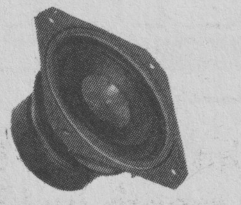
1K.WATT SLIDE DIMMER



- Controls loads up to 1KW
- Compact size 4¾" × 13/16" × 2½"
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

Innumerable applications in industry, the home, and discos/theatres etc.

Price: **£11.70** each + **50p** P&P
(Any quantity)



GENERAL PURPOSE 4½" MINI SPEAKER

General purpose full range loudspeaker, ideal for mini systems etc.
●Rolled fabric surround ●Twin cone ●8ohm impedance ●15 watt RMS ●1" voice coil ●13oz magnet ●Frequency range 50/15000Hz
Price: **£6.90** each + **75p** P&P

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: **£28.50** + £2.50 P&P

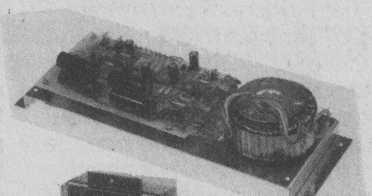
NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price:–

15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.50 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £2.50 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1½" aluminium voice coil, Resonant Frequency 40Hz, Frequency Response to 6KHz, Sensitivity 92dB. Also available with black cone fitted with black metal protective grill. **Price: White cone £8.90 each. Black cone/grill £9.50 each.** P & P £1.25 each.

OMP | **POWER AMPLIFIER MODULES**

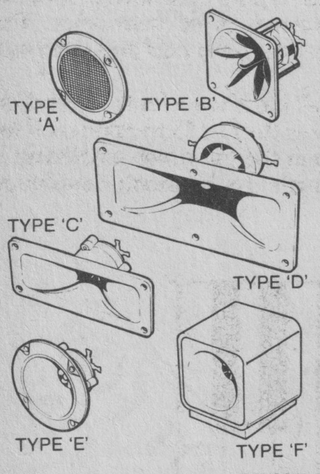


Vu Meter

100 WATT R.M.S.
Power Amplifier Modules with integral toroidal transformer power supply and heat sink. Supplied as one **complete** built and tested unit. Can be fitted in minutes. Auxilliary stabilised supply and drive circuit incorporated to power an L.E.D. V.u. meter, available as an optional extra.
SPECIFICATION:
Max. output power 100 watts R.M.S. (OMP100)
Loads: (Open and short circuit proof) 4-16 ohms
Frequency Response 20Hz-25KHz ± 3dB
Sensitivity for 100 watts 500mV at 10K
T.H.D. 00.1%
Size: 360 × 115 × 80mm

Prices:		
OMP 100W	**£29.99**	£2.00 P&P
OMP 150W	**£39.99**	£2.00
V.u. Meter	**£6.50**	

PIEZO ELECTRIC TWEETERS – MOTOROLA
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £3.45 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.35 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.45 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £6.90 each.**

TYPE 'E' (KSN1038A) 1¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.35 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each.**
U.K. post free (or SAE for Piezo leaflets).

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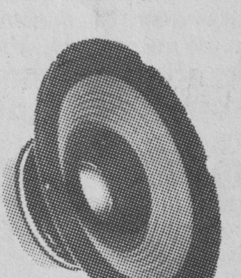

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ELECTROMUSIC TECHNIQUES

Tim Orr, our tame electronic designer, emerged from his workshop this month just long enough to hand over this bundle of circuits for the ardent build-it-yourself musician.

Virtually all of the electronic music synthesisers that have been produced to date employ analogue circuits to generate the synthesised sounds. The process is known as subtractive synthesis, and operates by dynamically filtering out parts of the spectrum of a signal that is often rich in harmonics. The results are instant, easy to modify and relatively inexpensive to implement. It is not possible to produce an arbitrary output spectrum, and so it is very difficult to synthesise realistic copies of naturally generated sounds. This can be done using a digital technique known as harmonic synthesis, whereby the sound is constructed by precisely defining the amplitude and phase of each of the harmonics. These are then added together to produce the output. However, natural sounds are constantly varying and so the data defining all the harmonics must also vary. Harmonic synthesis can produce very realistic sounds and is in itself a powerful technique for generating completely new sounds, but the hardware is a combination of sophisticated microprocessor and digital technology and so is outside the scope of this article.

When we hear a sound we unconsciously analyse it for useful information; "Who wants another drink?" for example. Nobody knows how the human brain analyses incoming sounds, but it does it with incredible speed and sophistication. It can extract precise information from sounds (speech perception), it can experience pleasure from a rich harmony, or it can even learn to ignore certain sounds, such as a ticking clock. The brain is very good at perceiving pitch (or at least it thinks it is; it is also a fairly good liar); see Fig. 1. When you hear a pure tone you will get a strong impression of its pitch. You will not be able to define its frequency in Hertz, but you will be able to remember its pitch. A sawtooth has a strong harmonic structure but even so you will get the same pitch perception. The ringing tone has virtually no energy at the fundamental frequency and yet it is still possible to correctly perceive the pitch of the signal, although it is more difficult than for the pure tone.

Most musical instruments produce a range of notes. Some instruments, like violins, can produce a continuous range of frequencies; because, unlike the guitar, there are no frets along the neck of the instrument. Keyboard instruments have fixed tuning; the piano, for example. The keyboard is an excellent choice for controlling a synthesiser, as it is easily converted so that it generates suitable electrical signals and it is widely accepted by musicians. Equal temperament tuning is used, that is there are twelve notes per octave and they are spaced at intervals of the twelfth root of two (that is 1.0594631) along an exponential curve, as in Fig. 2.

When You Hear The Tone...

The keyboard is used to define the fundamental pitch of a sound, but the actual shape of the waveform will determine its harmonic structure (Fig. 3). A sinewave is a pure tone and has no harmonics. A halfwave-rectified sine wave contains a fundamental plus a series of *even* harmonics. A fullwave-rectified sine wave is composed entirely of *even* harmonics. The squarewave and the triangle are both composed of a series of *odd* harmonics; in fact if you lowpass filter a square wave you can produce a triangle. The triangle is a fairly pure tone, with little of the energy in the waveform contained in its harmonics. The sawtooth is a rich waveform, having both *odd* and *even* harmonics.

The harmonic structure of all these waveforms extends to infinity, but the drawings only show the first 15 harmonics. If we call the harmonic number n, then the harmonic amplitude is easy to define. The rate at which the harmonic amplitude

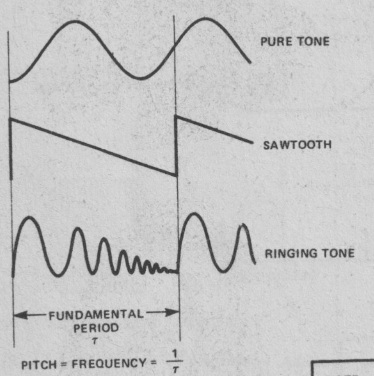
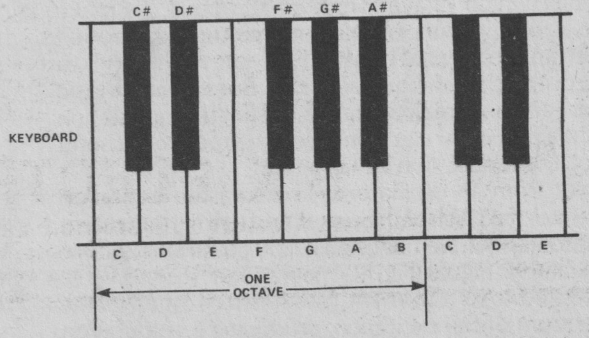


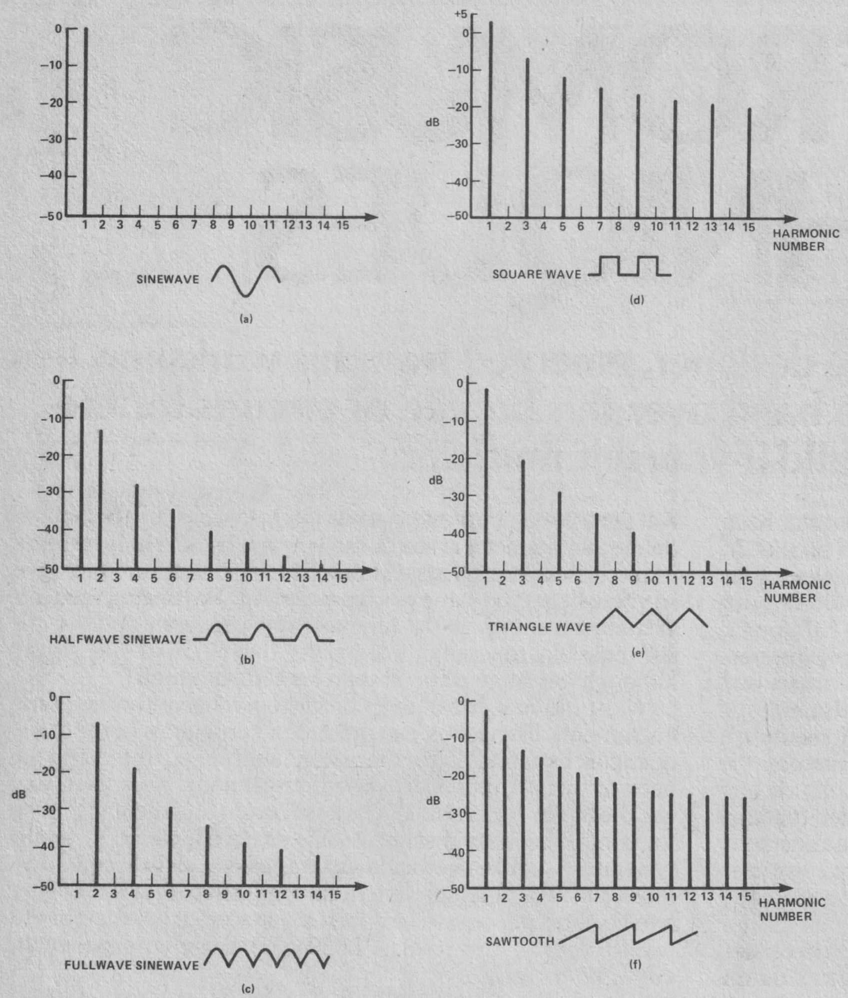
Fig. 1 Pitch perception.

NOTE	FREQUENCY (Hz)
A0	27.5
A1	55.0
A2	110.0
A3	220.0
A4	440.0
A5	880.0
A6	1760.0
A7	3520.0

Fig. 2 (below) Keyboard layout with table showing equal temperament tuning.

NOTE	FREQUENCY (Hz)	RATIO
C4	261.6	1.0000
C4#	277.2	1.0595
D4	293.7	1.1225
D4#	311.1	1.1892
E4	329.7	1.2599
F4	349.2	1.3348
F4#	370.0	1.4142
G4	392.0	1.4983
G4#	415.3	1.5874
A4	440.0	1.6818
A4#	466.1	1.7818
B4	493.9	1.8877
C5	523.2	2.0000





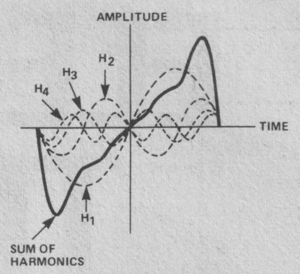


Fig. 4 Adding the first four harmonics to construct a sawtooth waveform.

Fig. 3 Harmonic structure of various standard musical waveforms.

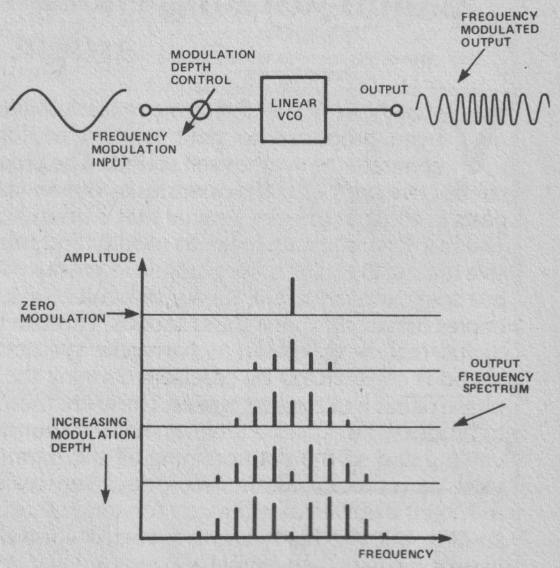


Fig. 5 The effects of frequency modulation.

decreases is 1/n for the sawtooth and square wave and $1/n^2$ for the half and fullwave rectified sine wave and the triangle. Figure 4 shows a sawtooth being constructed from harmonics. The sum of the harmonics is beginning to look like a sawtooth. As more harmonics are added (with the correct phase and amplitude) the sum will converge upon the correct sawtooth shape. An interesting effect can be produced by changing the mark/space ratio of the square wave. This modifies the *odd* harmonic spectrum and introduces *even* harmonics. The mark/space ratio is often dynamically modified as a synthesis process.

Frequency modulation is often employed in synthesisers to produce vibrato and other dramatic pitch change effects. Figure 5 shows some of the effects of frequency modulation. As the modulation depth is increased, frequency sidebands are generated. Their spacing and amplitude are determined by the modulation depth and the modulation and carrier frequencies. To precisely calculate them involves some complex maths and Bessel functions (which I have forgotten all about). To make matters worse, synthesisers usually use voltage controlled oscillators with an exponential transfer function, which tends to exponentially distort the sideband positions. But so what! Music synthesisers are all about making music and not the calculation of sidebands. If a particular electronic device produces a useful musical effect, then use it, don't analyse it.

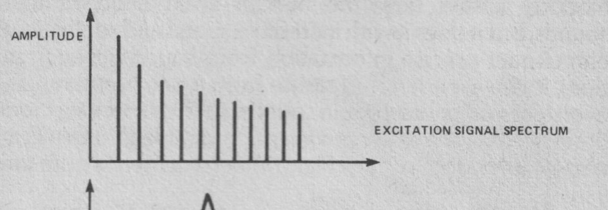


Fig. 6 The effect of filtering an excitation signal.

The output from an oscillator is known as an excitation signal. This defines the pitch of the signal, and to a certain extent the harmonic content of the final signal. It is common practice to filter the excitation signal (Fig. 6). The frequency response of the filter is referred to as a formant. The formant modifies the harmonic spectrum of the excitation, producing a colouration of the sound. The format is usually a mobile filter and this makes it possible to dynamically alter the sound colour. If the formant has a sharp resonant peak, then the output signal will ring as it passes the harmonics of the excitation.

Another parameter that characterises a sound is its

amplitude contour or envelope (Fig. 7). A sound that has a sharp attack and a slow release is similar to a plucked instrument. Other envelopes will make the sound seem like something else.

Building Blocks

Most synthesisers are constructed from standard building blocks, and most of these blocks are voltage controlled. This is a very powerful concept, because it enables you to control a unit with a combination of control voltages and/or audio signals. Building blocks can be patched together in any arbitary order to produce any system that is wanted. Some standard building blocks are detailed below.

Voltage Controlled Oscillator Used to generate the pitched excitation signals. Often a VCO will generate a wide range of waveforms. The control sensitivity is usually +1 V/octave. Therefore a one twelfth of a volt change will alter the oscillator pitch by one semitone. The exponential control law is a very powerful concept. If a VCO is being driven so that it produces a melody, then adding +1 V to the control input will transpose the melody up by one octave. Thus musical transpositions are very simple to produce. Often more than one VCO will be used, so that a rich chord is obtained.

Voltage Controlled Filter This is used as a formant for the excitation signal. The VCF is generally a lowpass filter, but it can often be a multi-mode device with lowpass, highpass, bandpass and notch responses. The VCF also has a Q (resonance) control. The control sensitivity is +1 V/octave for the frequency parameter, and undefined for the Q.

Voltage Controlled Amplifier The VCA controls the level of audio signals. The control law can be linear or logarithmic. The VCA is usually controlled by an ADSR unit and is employed to generate signal envelope contours. The device is a two quadrant multiplier.

Attack, Decay, Sustain, Release unit The ADSR is used to generate the signal envelope contour and also the VCF sweep waveform.

Ring Modulator This is a four quadrant multiplier or balanced multiplier. The output voltage is the product of the two input signals. It is often used to generate discordant or clangerous sounds.

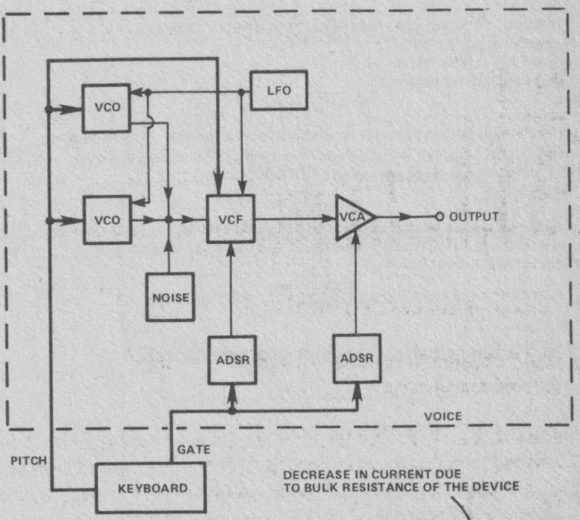
Noise source Generates random noise, which can be used in the synthesis of non-pitched sounds such as explosions. Filtered or sampled noise can be used as a random control voltage.

Low Frequency Oscillator These oscillators are used to generate vibrato in the VCO or a filter sweep in the VCF.

Keyboard Musical control interface, generating pitch voltages of +1 V/octave and also a gate signal to indicate that a note is pressed. A monophonic keyboard only allows one note at a time to be pressed, but if more than one can be pressed simultaneously then the system is polyphonic.

There are several other building blocks such as flangers, sequencers, frequency shifters, and pitch detectors, but there isn't enough space to deal with them.

Polyphonic synthesisers tend to be voice-based; ie all the building blocks are pre-routed to form a voice (Fig. 8). Modular systems are not pre-routed and have to be patched, either with lots of jack-to-jack patch leads or via a matrix patch board using patch pins. Patch leads are relatively inexpensive, but the leads get in the way and it is often difficult to see just what you have patched. Matrix patch boards are easy to understand, but they suffer from crosstalk and a large board (60 by 60) might cost £500!



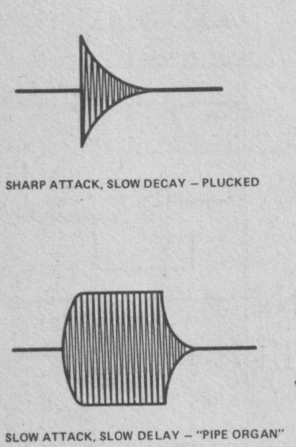


Fig. 7 (Above) Two typical amplitude contours, or envelopes.

Fig. 8 (Top right) The standard synthesiser voice.

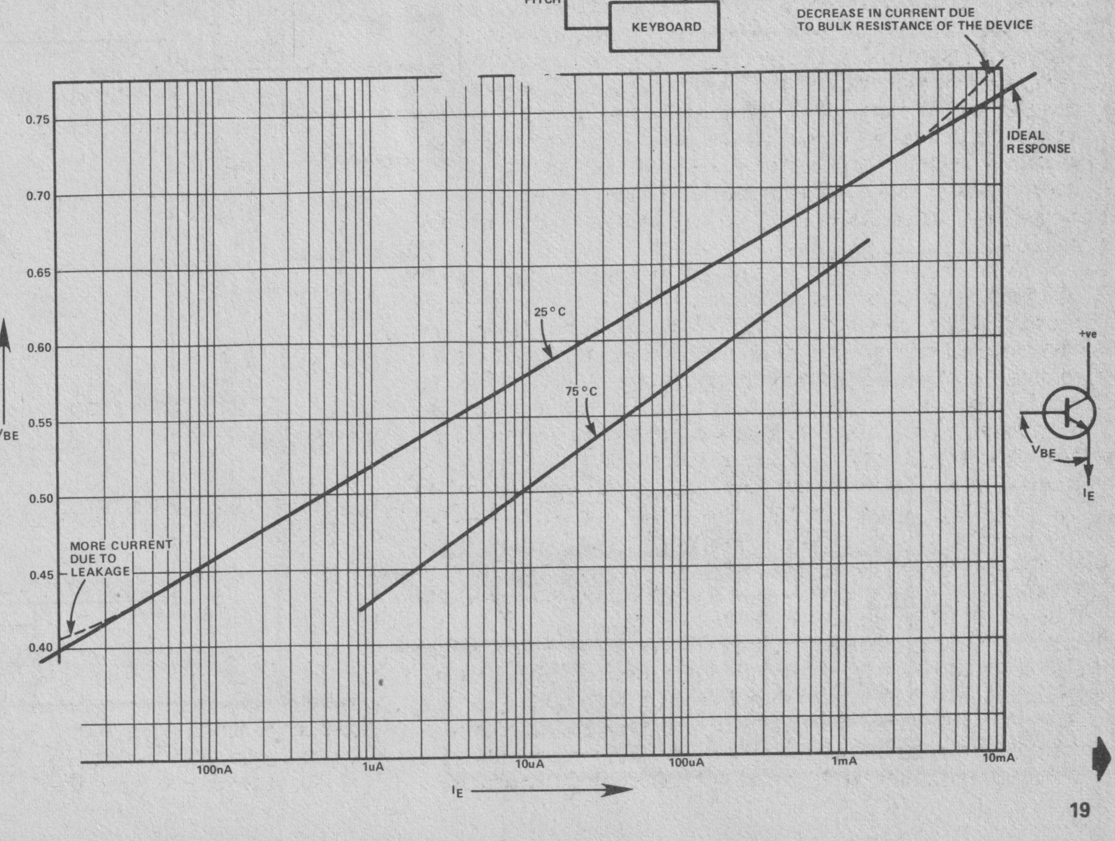
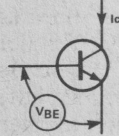


Fig. 9 (Right) Silicon diode transfer characteristics.

Diode Data

The silicon diode has an exponential transfer function, that is the diode current increases exponentially for linear increments in the diode voltage (Fig. 9). This can be used to turn linear changes from, say, a keyboard into exponential or musical intervals in a VCO. The required musical range is probably no more than 200 to 1 and so a suitable operating current would be 0.5 uA to 100 uA, thus avoiding the non-exponential parts of the curve. The silicon diode is temperature dependent (it is often used as a thermometer) and so great care must be used to avoid thermal problems. The junction voltage changes by −1.9 mV/°C, but a semitone change is equivalent to 1.5 mV, therefore a 1°C change could result in a 1.27 semitone change in pitch! Figure 9 shows two temperature effects in operation; there is a large shift and the slope of the line changes.

Figure 10 illustrates the equations that determine the diode operation. Two facts emerge from these equations. First, an 18 mV change in V_{BE} will double the current I_C, and second, this parameter has a temperature coefficient of −0.33%/°C. Both the temperature problems can be resolved by using a circuit similar to that shown in Fig. 11. Transistor Q1 is run at constant current (12 uA) by the op-amp. Q2 is used as the exponentiator transistor. The emitter of Q2 is held at a voltage of about −0V6. Any voltage change at the base of Q2 will result in an exponen-



$I_c = I_o\,(e^{\{qV_{BE}/KT\}} - 1)$

$\therefore\ I_c \simeq I_o\,e^{qV_{BE}/KT}$

WHERE
Io IS THE EMITTER SATURATION CURRENT
K IS BOLTZMANNS CONSTANT
q IS THE CHARGE ON AN ELECTRON
T IS THE TEMPERATURE IN °K

HOWEVER, $\frac{KT}{q}$ IS 26mV AT 28.58 °C (301.73 °K IS ROOM TEMPERATURE).
THEREFORE, $I_c \simeq I_o\,e^{V_{BE}/26}$
WHERE V_{BE} IS MEASURED IN mV
REARRANGING THE EQUATION,

$$26.\ \ln\left(\frac{I_c}{I_o}\right) = V_{BE}$$

THEREFORE, AN OCTAVE CHANGE IN Ic IS CAUSED BY A 18.021827mV CHANGE IN V_{BE} (AT 28.58 °C). HOWEVER, IF THE TEMPERATURE WERE +1 °C HIGHER, THEN V_{BE} WOULD HAVE TO BE INCREASED IN SIZE TO A NEW VALUE OF

$$26 \times \left(\frac{302.73}{301.73}\right)$$

SO, FOR AN OCTAVE CHANGE IN Ic AT THE NEW TEMPERATURE, V_{BE} MUST CHANGE BY 18.08155mV, AN INCREASE OF 0.059723mV. THIS CAN BE EXPRESSED AS A PERCENTAGE CHANGE PER °C :–

$$\text{TEMPERATURE SENSITIVITY} = \frac{0.059723 \times 100}{18.021827} = 0.33139\%/°C$$

Fig. 10 Exponential transistor characteristics.

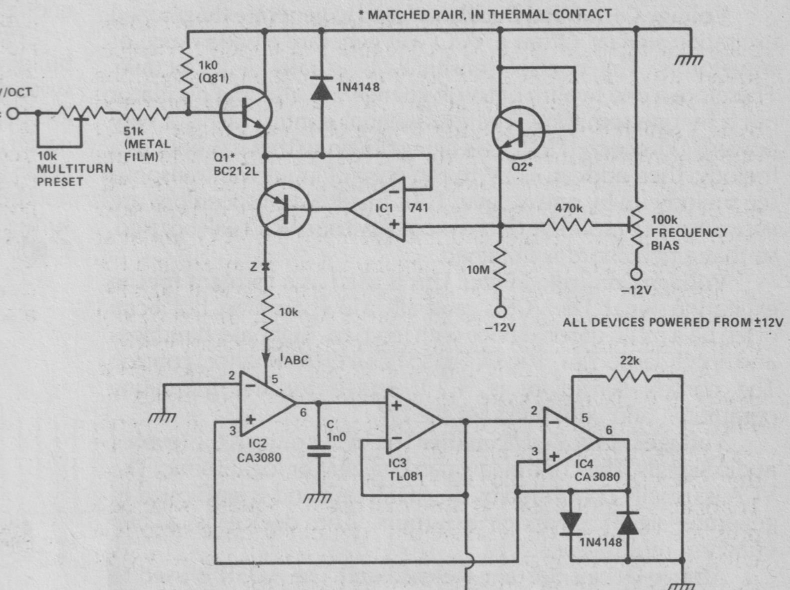
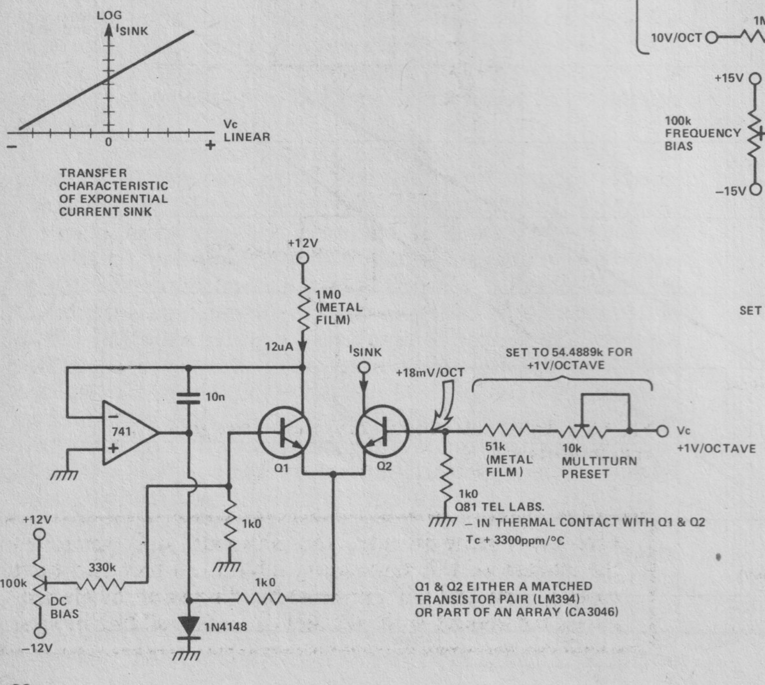


Fig. 12 An exponential VCO.

Fig. 11 (Below) An exponential current sink.



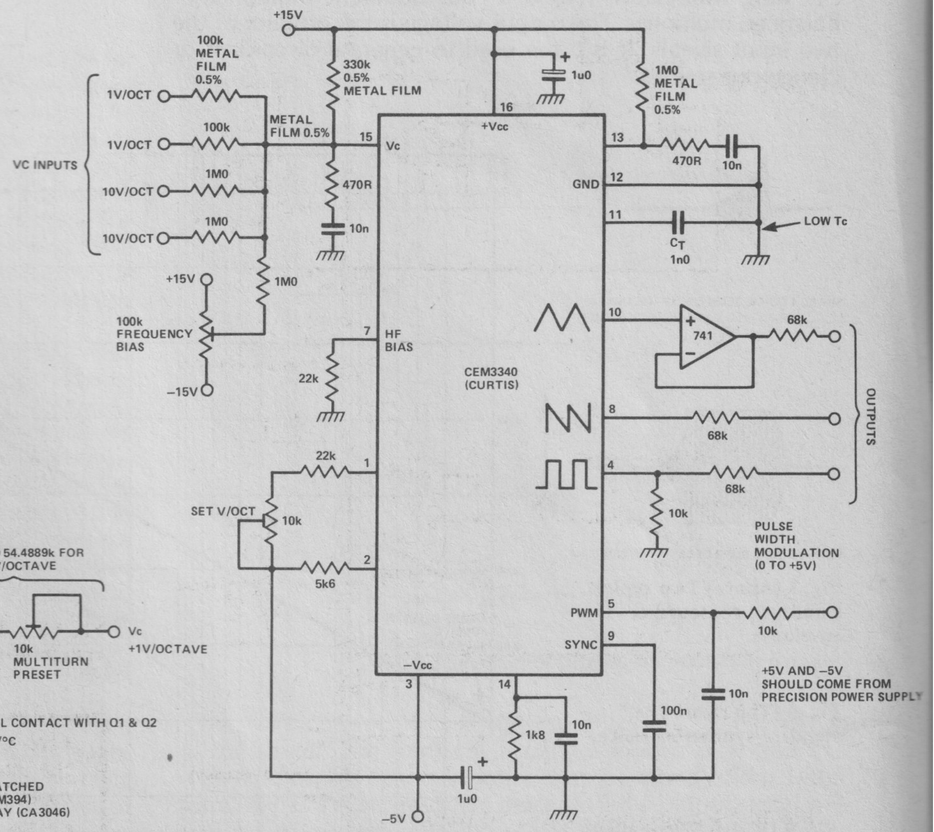


Fig. 13 A VCO using a monolithic device.

tial change in the collector current of Q2. Q1 and Q2 are in thermal contact and so any temperature change will effect both equally. Thus the −1.9 mV/°C factor is cancelled out by Q1 acting as a compensating thermometer for Q2. The slope change is removed by using a temperature sensitive resistance (Q81 — Tel Labs) which has an equal but opposite temperature coefficient to the diode junction. This resistor is often in thermal contact with the matched transistors. If this circuit is connected to a linear current controlled oscillator, a musical VCO is produced.

VCO Circuits

Figure 12 is the circuit for an exponential VCO using an exponential current source. The oscillator is a standard triangle-square wave device. IC2 is a current-controlled integrator; the slow rate at its output is equal to I_{ABC}/C. This voltage is buffered by IC3 which drives a Schmitt trigger IC4. The output of IC2 ramps up and down between the two hysteresis levels which are determined by the two clamping diodes connected to the output of IC4. Any stray capacitance on the output of IC4 will slow down the Schmitt trigger and this will make the VCO go flat at high frequencies. Also the propagation time delay around the oscillator will cause a flattening out ot the response at high frequencies. These effects can be nulled out but they may not even affect things if the VCO frequency is kept relatively low.

A very good VCO is shown in Fig. 13. It is a monolithic device, the CEM3340 from Curtis Electromusic Specialities Inc who make a range of electronic music devices. As can be seen, very few external parts are needed to implement the VCO. All the temperature compensation is performed inside the chip. Triangle, sawtooth and variable mark/space square wave outputs are simultaneously available. The mark/space ratio is a voltage controlled parameter. A sync input is also provided so that the VCO can be slaved to another oscillator.

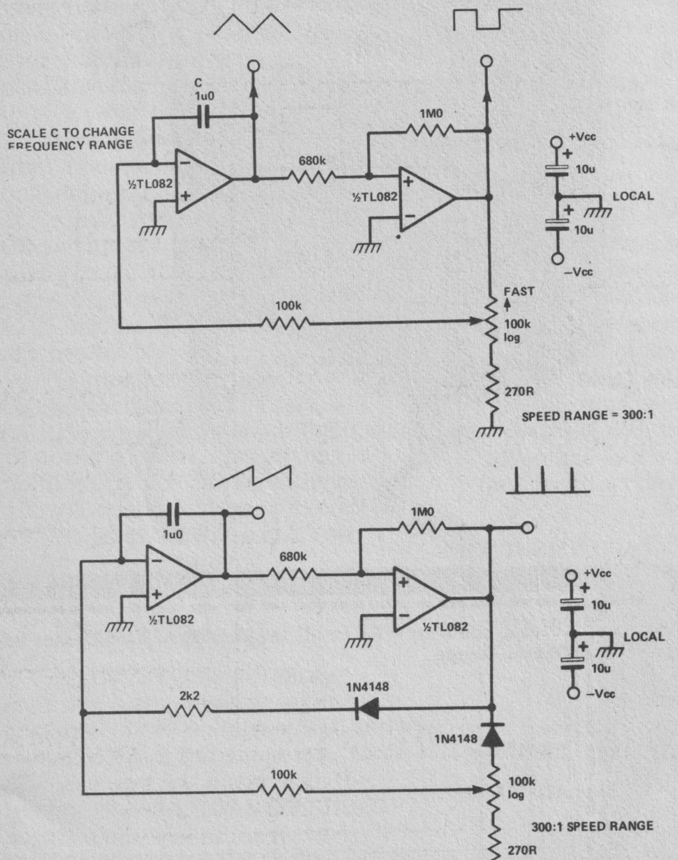


Fig. 14 A triangle/square wave LFO (top) and a sawtooth/pulse LFO (bottom).

LFO Circuits

A couple of LFO units are shown in Fig. 14. All four output waveforms can be usefully employed to sweep VCOs and VCFs. Often the waveforms are mixed together to produce strange frequency modulations. When the sawtooth is fed into one side of a ring modulator and noise into the other, a beat track can be generated; it sounds a bit like a cymbal being hit.

Noise Generators

In 'the old days' noise sources were made by amplifying the noise current of a diode junction that was zenering. These were a bit unreliable, and always involved selecting the device. However, noise can be generated digitally with a maximum length pseudorandom sequence generator (Fig. 15). The noise spectrum is relatively flat and always the same. If you slow down the clock rate you can get some interesting sounds; I think that this is used on some TV games. If a longer shift register is used, say 30 or 40 stages (the 4006 is 18 stages long), and the noise source is turned on, a tone is initially heard which gradually changes into noise as the sequence becomes more scrambled up. You can purchase a monolithic noise generator (pseudo-random); it is the MM5837 made by National Semiconductor, also sold by AMI with the part number S2688.

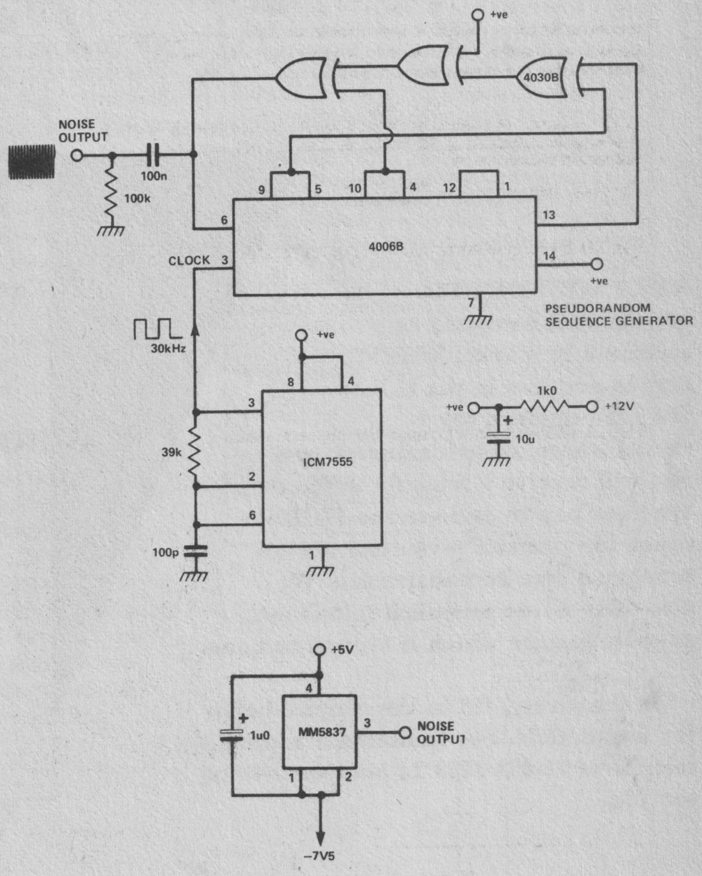


Fig. 15 A digital noise source (top) and a noise generator chip (bottom).

Five pages gone already, and we've still only scratched the surface of this fascinating subject. In part two next month, Tim Orr will continue his discussion of electro-music techniques with yet more circuit building blocks.

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ETI/4

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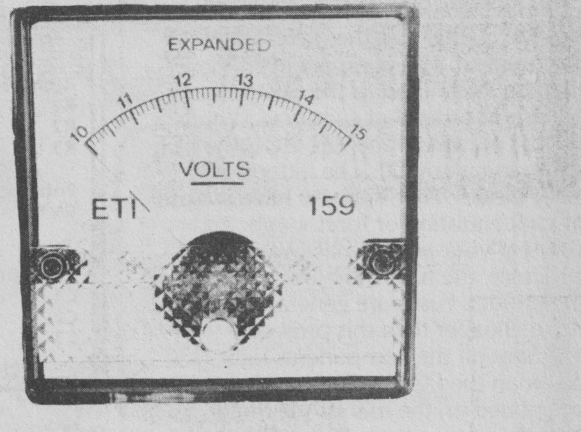


This simple, low-cost instrument can be built into power supplies or used as a portable or fixed 'battery condition' monitoring meter. Design by Simon Campbell and Roger Harrison.

Common storage batteries to power nominal 12 V DC electrical systems have a terminal voltage that ranges from a little over 10 V when discharged to around 15 V when fully charged, the operating voltage being somewhere in the range 11V5 to 13V8. Lead-acid batteries, for example, may have a terminal voltage under rated discharge that commences at around 14V2 and drops to about 11V8. A 12 V (nominal) nickel-cadmium battery may typically have a terminal voltage under rated discharge that starts at 13 V, dropping to 11 V when discharged.

Equipment designed to operate from a nominal 12 V DC supply may only deliver its specified performance at a supply voltage of 13V8 — mobile CB and amateur transceivers being a case in point. Other DC operated equipment may perform properly at 12V5 but 'complain' when the supply reaches 14V5.

To monitor the state of charge/discharge of a battery, a battery-operated system or the output of power supplies, chargers, etc, a voltmeter which can be easily read to 100 mV over the range of interest (10 to 15 V) is an invaluable asset. This project does just that.

The Circuit

An LM723 variable voltage regulator is employed to set an accurate 'offset' voltage of 5 V, and the meter (M1) plus the trimpot RV2 and R3 make up a 5 V meter, with the trimpot allowing calibration. The negative terminal of the meter is connected to the output of the 723 so that it is always held at 5 V 'above' the circuit negative line. The positive end of the meter goes to a zener which will not conduct until more than 5 V appears between the circuit +ve and −ve lines. Thus the meter will not have forward current flowing through it until the voltage between the +ve and −ve rails is greater than 10 V, and will read full scale when it reaches 15 V (after RV2 is set correctly).

The meter scale limits may be adjusted by setting the output of the 723 higher or lower (adjusted by RV1) and setting RV2 so that the meter has an increased or decreased full-scale deflection range.

A variety of meter makes and sizes may be used.

Construction

Mechanical construction of this project has been arranged so that the PCB can be accommodated on the rear of any of the commonly available moving coil meter movements. We chose a meter with a 55 mm wide scale (overall panel width, 82 mm). A meter movement with a large scale is an advantage as it is considerably easier (and more accurate) to read than

HOW IT WORKS

The meter, M1, is a 1 mA meter with series resistance — made up of R3 and RV2 — so that it becomes a 0-5V voltmeter. The negative end of the meter is maintained at 5 V above the circuit negative line by the output of IC1, a 723 adjustable regulator. The positive end of the meter is connected to the circuit positive line via ZD1, a 4V7 zener diode. Thus, no 'forward' current will flow in the meter until the voltage between the circuit negative line and the circuit positive line is greater than 5 + 4.7 = 9V7.

Bias current for the zener is provided by a FET, Q1, connected as a constant current source so that the zener current is accurately maintained over the range of circuit input voltage. This ensures the zener voltage remains essentially constant so that meter reading accuracy is maintained.

The trimpot RV1 sets the output voltage of the 723. This determines the lower scale voltage. Trimpot RV2 sets the meter scale range, less resistance decreases it.

Diode D1 protects the circuit against damage from reverse connection.

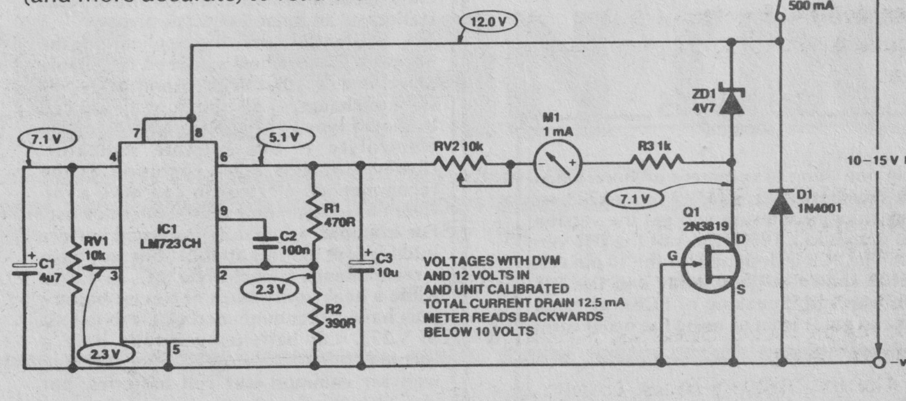


Fig. 1 Circuit diagram for the Voltage Monitor.

Having chosen your meter, drill out the PCB to suit the meter terminal spacing first. The components may then be assembled to the board in any particular order that suits you. Watch the orientation of the 723, ZD1, the FET and particularly D1. The latter is an 'idiot diode'. That is, if you have a lapse of concentration or forethought and connect your project backwards across a battery, the fuse will blow and not the project. Fuses are generally found to be cheaper than this project!

Seat all the components right down on the PCB as the board may be positioned on the rear of the meter with the components facing the meter. The size of C2 may give you a little trouble. Polyesters are generally too large and therefore unsuitable. We used a ceramic type capacitor — as commonly used on computer PCBs as bypasses. Alternatively, a 100n tantalum capacitor (+ve to pin 2 of IC1) may be used. The actual value or type of capacitor is not all that critical.

We have used multiturn trimpots for RV1 and RV2 as they make the setting up a whole lot easier.

PARTS LIST

Resistors (all ¼ W, 5% metal film)

R1	470R
R2	390R
R3	1k0

Potentiometers

RV1,2	10k cermet multiturn horizontal trimpot

Capacitors

C1	4u7 10 V tantalum
C2	100n ceramic
C3	10u 10 V tantalum

Semiconductors

IC1	LM723 (see Buylines)
Q1	2N3819
D1	1N4002 or similar
ZD1	4V7 400 mW or 1 W zener

Miscellaneous

M1	1 mA meter (see text)
FS1	500 mA fuse and in-line fuse holder

PCB (see Buylines); meter scale to suit meter; red and black cable, etc.

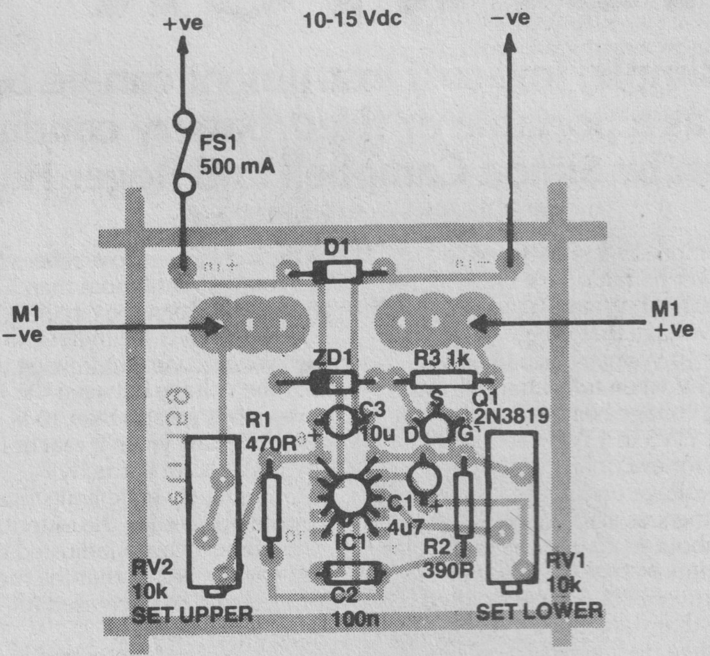


Fig. 2 Component overlay for the Voltage monitor. Note that IC1 is in a 10-pin T099 case.

Calibration

For this you will need a variable power supply covering 10 to 15 V and a digital multimeter (borrow one for the occasion).

First set the 10 V point. Connect the digital multimeter across the power supply output and adjust the power supply to obtain 10.00 V. Set the mechanical zero on the meter movement to zero the meter's pointer. Connect the unit to the power supply output and adjust RV1 to zero the meter needle.

Next, set the power supply to obtain 15.00 V. Now adjust RV2 so that the meter needle sits on 15 V (full scale). Check the meter reading with the power supply output set at various voltages across the range. We were able to obtain readings across the full scale within ± half a scale reading (±50 mV). With a 2% FSD accuracy meter the worst error may be about ± one scale division.

BUYLINES

Only one thing to comment on here; when you purchase your LM723 (or uA723 — same thing) make sure you get the version that comes in a T099 case, not the DIL version. The PCB is designed for the 10 pin version as shown in the overlay and the DIL type won't fit. Speaking of PCBs, as usual you can get it from us using the order form on page 44.

BATTERY CONDITION AND TERMINAL VOLTAGE

The 12 V battery, in its many forms, is a pretty well universal source of mobile or portable electric power. There are lead-acid wet cell types, lead-acid gel electrolyte (sealed) types, sealed and vented nickel cadmium types, and so on. They are to be found in cars, trucks, tractors, portable lighting plants, receivers, transceivers, aircraft, electric fences and microwave relay stations — to name but a few areas.

No matter what the application, the occasion arises when you need to reliably determine the battery's condition — its state of charge, or discharge. With wet cell lead-acid types, the specific gravity of the electrolyte is one reliable indicator. However, it gets a bit confusing as the recommended electrolyte can have a different S.G. depending on the intended use. For example, a low duty lead-acid battery intended for lighting applications may have a recommended electrolyte S.G. of 1.210, while a heavy-duty truck or tractor battery may have a recommended electrolyte S.G. of 1.275. Car batteries generally have a recommended S.G. of 1.260. That's all very well for common wet cell batteries, but measuring the electrolyte S.G. of sealed lead-acid or nickel-cadmium batteries is out of the question.

With NiCads, the electrolyte doesn't change during charge or discharge.

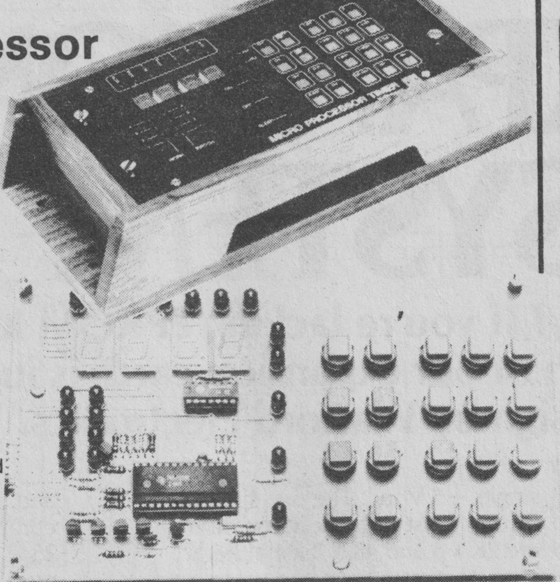
Fortunately, the terminal voltage is a good indicator of the state of charge or discharge. In general, the terminal voltage of a battery will be at a defined minimum when discharged (generally between 10 and 11 V), and rise to a defined maximum when fully charged (generally around 15 V). Under load, the terminal voltage will vary between these limits, depending on the battery's condition.

Hence a voltmeter having a scale 'spread' to read between these two extremes is a very good and useful indicator of battery condition. It's a lot less messy and more convenient than wielding a hydrometer to measure specific gravity of the electrolyte!

The charge and discharge characteristics of typical lead-acid and sealed NiCad batteries are given in the accompanying figures.

ELECTRONIC KITS

Micro-processor universal Timer



This incredibly versatile programmable timer can control up to 20 functions at accurately timed intervals over a period of a week. Originally developed for industrial and laboratory use it offers many interesting and exciting possibilities for the amateur constructor.
Based on a pre-programmed TMS 1000 Microprocessor, the unit provides a 24 hour clock with four independent relay controlled outputs with a programmable period of one week. Up to 20 daily or weekly programmable functions can be set via a keyboard. Any of the timer functions can be assigned to control any one of the four relay outputs thus providing almost unlimited programming possibilities.
No previous experience of microprocessor programming is necessary since the manual explains all the possible operations, clearly and simply, enabling the inexperienced user to be fully conversant within one hour. Completed programme steps are indicated by LED's
The kit comes complete with printed panel and may be installed either as a 'built-in' or a 'free-standing' unit. A stabilised power supply mounted on a separate printed circuit board is supplied with the unit. It requires the addition of a 12V, 1A transformer. There is space on the board for up to four output control relays. One is supplied with the kit. Further relays maybe ordered separately as required. Price: *(excluding wooden housing as illustrated)* **£48.37** inclusive of VAT and **DELIVERED FREE** on U.K. mainland.

APPLICATIONS

The programmable timer can provide central control of domestic electrical cooking, heating and entertainment equipment.
The possibilities are limited only by the imagination of the user.
Control of house lighting to discourage intruders; control of TV or audio equipment; sound or video recording control; automatic plant watering; automatic pet doors or feeding—are a few simple examples.
For the professional or industrial user many uses in this area of process control will be found.

TECHNICAL DATA:
Power supply:
Mounted on separate pcb with space for up to four output control relays. Requires 12V/1A transformer.

CONTROL SWITCHING:
Standard relays (one supplied with kit) will switch 2A.
Additional relays may be ordered separately.
National relay, order no. HT 12V.
Siemans relay, order no. R1 INV12.

MICROPROCESSOR:
TMS 1000

DISPLAYS:
12mm 7 segment LED numerical display. LED programme function indicators.

DIFFICULTY GRADE: 3

KIT NUMBER: K1682

THE VELLEMAN KIT RANGE

- 2.2 Watt mini amplifier
- Mono VU using LED's
- 7 Watt amplifier
- Dimmer 1000 Watt
- Dimmer 1000 Watt(deparasite)
- High precision stopwatch
- Microprocessor Universal timer
- 20 Watt monolithic amplifier
- FM oscillator
- Stereo VU using LED's
- Universal mono pre-amplifier
- 60 Watt power amplifier
- Power supply 1 Amp
- Power supply for stereo 60 Watt amplifier
- Running light
- Digital panel meter
- Single digit counter
- Transistor ignition
- Complex sound generator
- 50 Hz crystal base
- 4 channel infra-red remote control (transmitter or receiver)
- Infra-red detection system (transmitter or receiver)
- Central alarm unit
- FM stereo decoder
- High quality FM tuner
- Digital frequency counter for receivers
- CB power supply 3.5 Amp 12V
- Digital thermometer
- FM stereo receiver (19 in. rack-mounting)
- 2 channel infra-red remote control light dimmer (transmitter or receiver)
- Infra-red receiver for tuner K2558
- Infra-red transmitter for tuner K2558
- Tape/slide synchronizer
- 3 channel coloured light organ
- 20 cm display (common anode)
- 20 cm display (common cathode)
- Three tone bell
- 5-14V DC 1 Amp Universal power supply
- Light computer
- Universal stereo pre-amplifier
- Stereo RIAA corrector amplifier
- Universal 4 digit up/down counter with comparator
- Microprocessor doorbell with 25 tunes
- 40 Watt audio amplifier
- Electric drill speed control
- Microprocessor-controlled EPROM programmer (kit form)
- Microprocessor-controlled EPROM programmer (built and tested)
- Universal start/stop timer

Repair Service available (for a nominal charge) if your soldering technique is not quite what it should be!

Any technical enquiries welcomed —in writing—and will be answered promptly by letter.

TRADE ENQUIRIES WELCOME

VELLEMAN UK
Limited

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ETI

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COMPUTER EXPANSION SYSTEM

How's your memory? If you're lacking EPROM and the ability to program it, the fourth of our expansion cards is just what you need. Design by Watford Electronics.

This month we present an EPROM programmer and associated EPROM cards suitable for the machine code freak to store away those beloved extra routines or the space invaders freak to capture his aliens in 0's and 1's for life.

The first major consideration when designing an EPROM programmer is just what EPROMs should it be capable of blowing. There is more than just a little confusion here. There are two basic types of EPROM currently available — those that run off a three rail supply and those that run from a single +5 V rail. The two sizes of PROM most popular at the moment are 2K x 8 and 4K x 8. Aha! here manufacturers have had some fun. Intersil and others like calling their triple rail PROMs 2716 and 2732 whereas Intel make their 2716 and 2732 single rail; not to be missed out Texas try to settle the balance by nominating their EPROMs 2516 and 2532; both are single rail!

To clear up the matter our programmer will program single rail EPROMs only, these being the most popular. It will program the Texas 2516 2K x 8 EPROM and Intel 2716 2K x 8 EPROM as these are pin-for-pin compatible (see Fig. 1). However, 2532 and 2732 4K x 8 EPROMs are not compatible and we have stuck to the 2532, as this then allows for use of the new 2764 8K x 8 EPROMs with the minimum alteration (see Fig. 2). If you wish to program 2764's then you must make the alterations to correct the $\overline{OE}$/V_{PP} and $\overline{CS}$ lines. A12 has been brought to pin 1 and power (V_{CC}) to pin 28.

Selection of the type of EPROM you want to program is made by means of a quad DIL switch. This switch is unusual in that each section operates two oppositely biased single pole switches — this means it can be

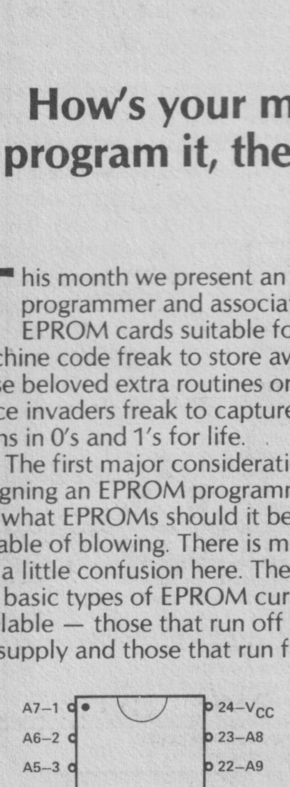


Fig. 1 You can program these EPROMs...

HOW IT WORKS

PROM PROGRAMMER
The heart of this board is two 6520 peripheral input-output chips — they serve to generate the address bus, the data and control signals for the chip being programmed.

R1 and C1 generate the power up reset; C4, 5 and 6 are included in for decoupling. The rather peculiar need of the V_{PP} pin for 0, +5 V and +25 V is met by the PSU and switching circuit. Transformer T1 supplies 30 V AC to the bridge which rectifies it and feeds it to smoothing capacitor C3. IC3 and ZD1 regulate this to +25 V DC. C2 is included in the interests of stability. Transistors Q1 and Q2 handle the switching of V_{PP} between 0, 5 and 25 V. This output is then fed to the DIL switch and then to the V_{PP} pin of the EPROM to be programmed. Ports A and B of IC2 are used to generate the address bus — note A12 is connected to pin 1 of the EPROM (on a 28 pin basis) for use later with 2764 EPROMS. The data bus is generated by port A of IC1, while port B of IC1 generates the control for V_{PP} and the $\overline{CS}$ and PGM lines which are switched with A11 to the correct pins of the EPROM by the DIL switch.

Inputs to the 6520s are straight from the expansion sockets — ϕ2 being used to enable the chips to reduce power consumption.

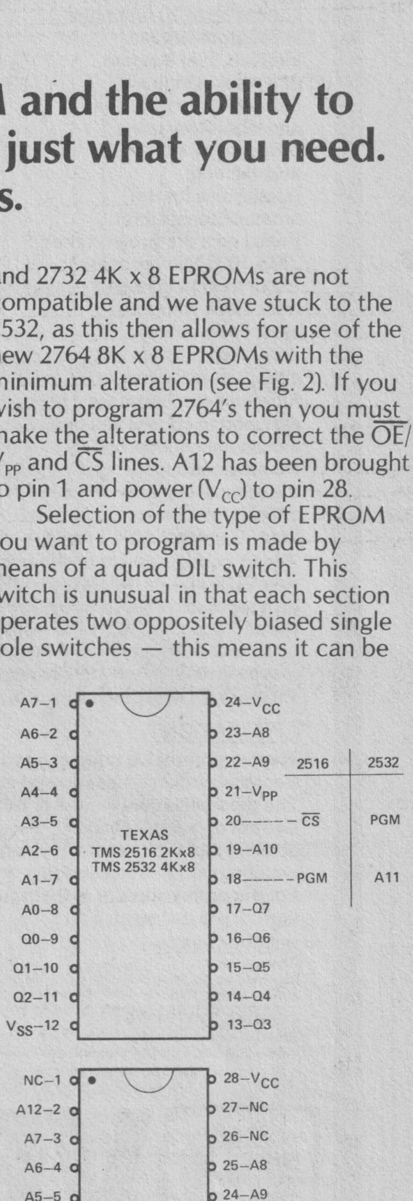


Fig. 2 ...or these ones.

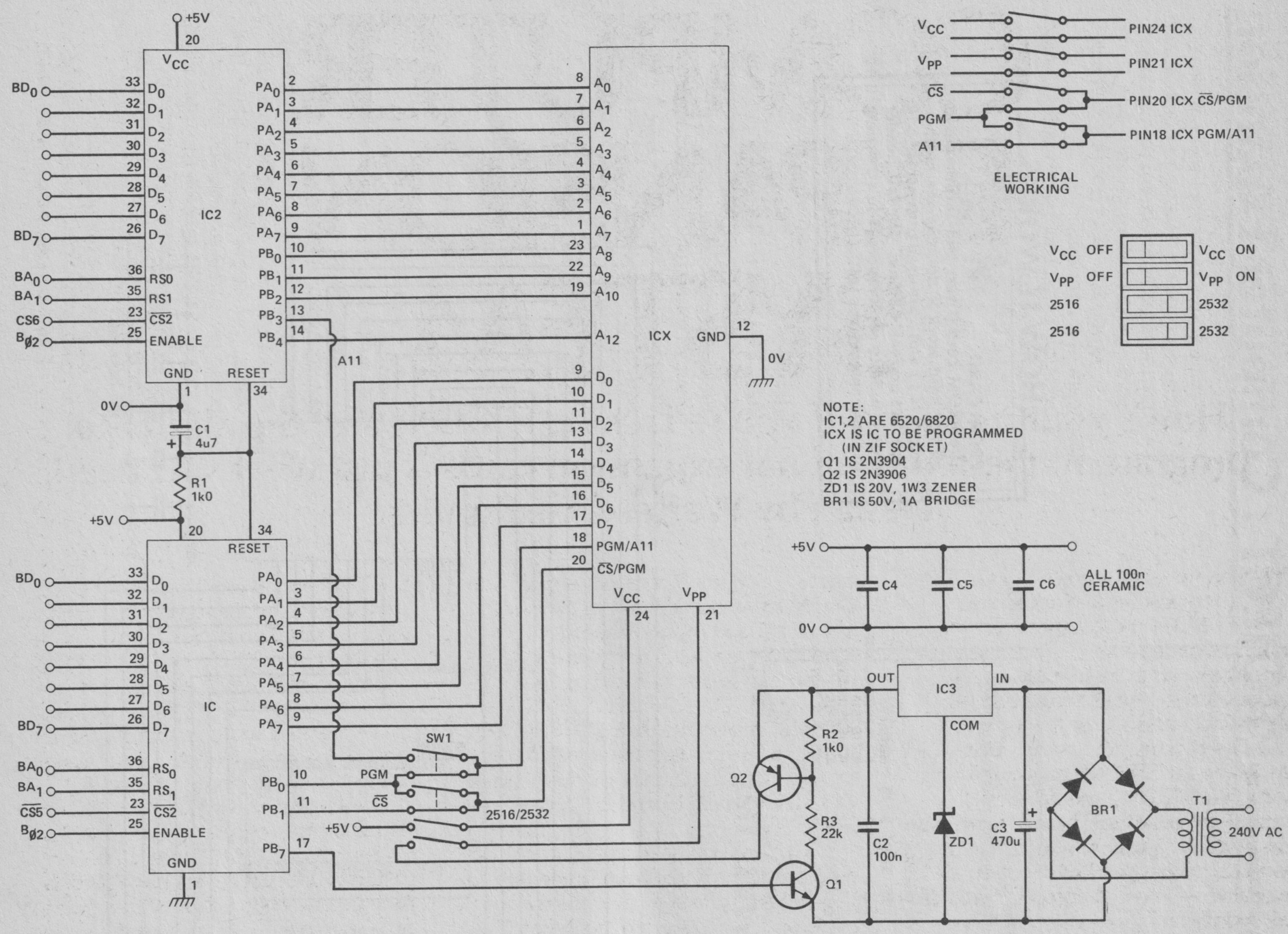


Fig. 3 Circuit diagram of the EPROM programmer, with details of SW1. ICX is the EPROM to be programmed.

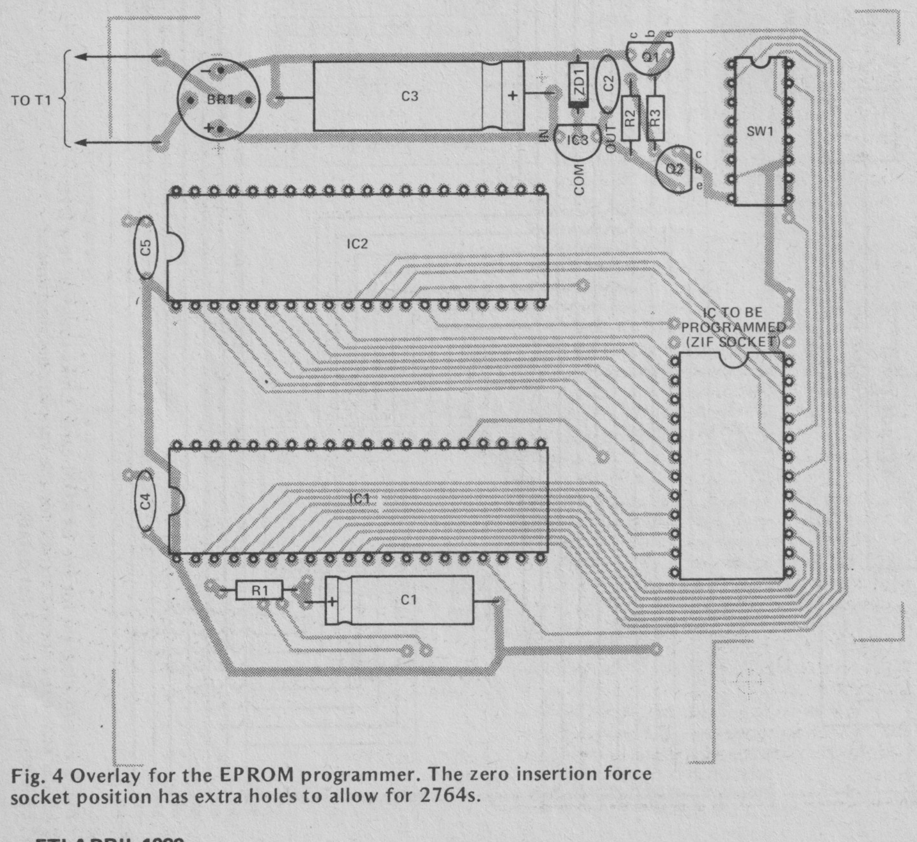


Fig. 4 Overlay for the EPROM programmer. The zero insertion force socket position has extra holes to allow for 2764s.

PARTS LIST

PROM PROGRAMMER

Resistors (all ¼ W, 5%)

R1,2	1k0
R3	22k

Capacitors

C1	4u7 25 V axial electrolytic
C2,4,5,6	100n ceramic
C3	470u axial electrolytic

Semiconductors

IC1,2	6520/6820
IC3	78L05
Q1	2N3904
Q2	2N3906
ZD1	20 V, 1W3 zener diode
BR1	1 A, 50 V bridge rectifier

Miscellaneous

SW1	Quad DPST DIL switch

PCB (see Buylines); DIL sockets; transformer (6 VA, 0-15-0-15)

used as a 4 pole changeover switch and makes it ideal for the job. Two of the four sections are used for chip power (+5 V) and the programming can be destroyed if V_{pp} is applied with V_{CC} disconnected. The other two sections are used to switch $\overline{CS}$, PGM and A11 to the correct pins of the ZIF socket according to whether a 2516 or 2532 is to be used.

PROJECT : Computer Expansion

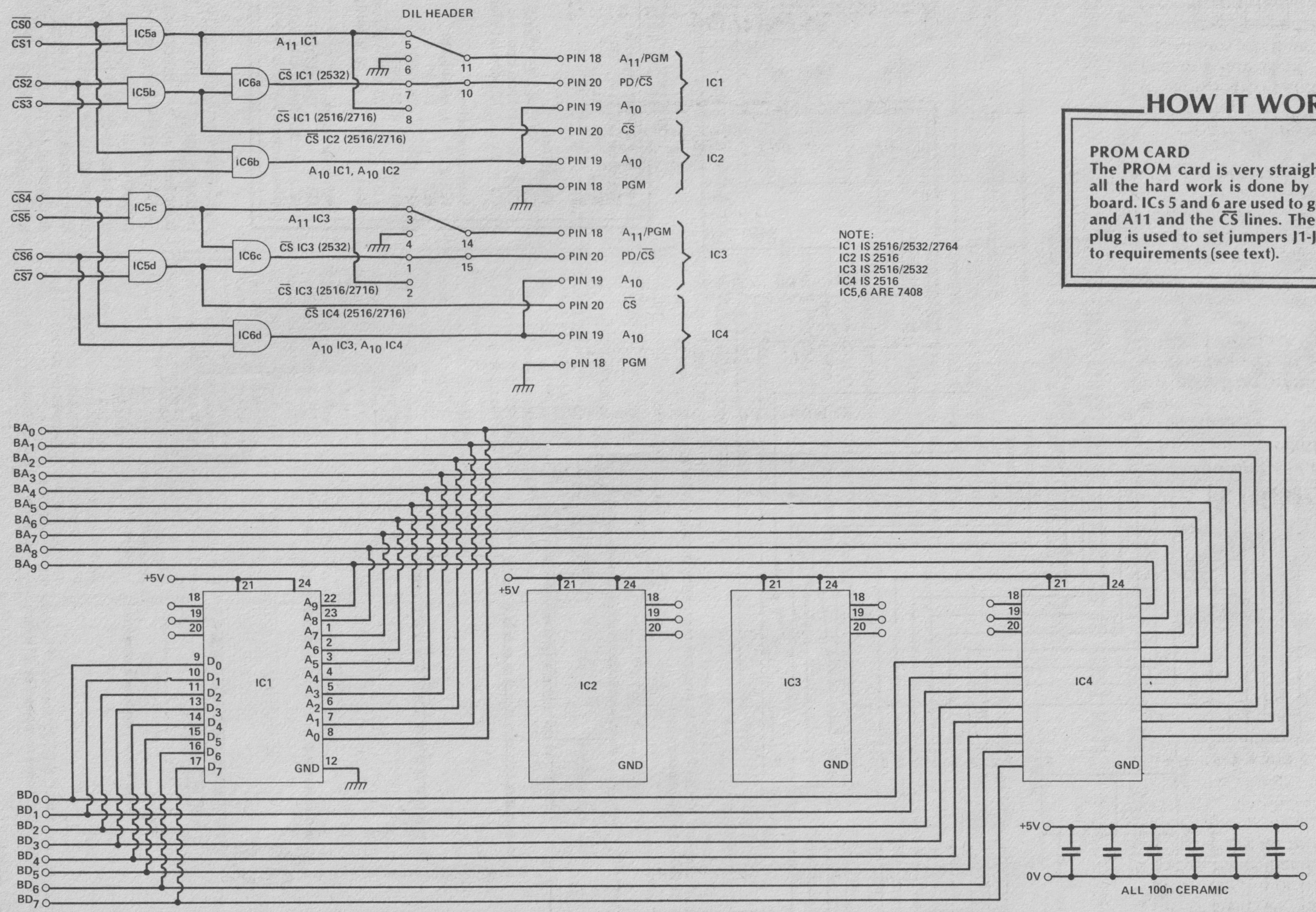


Fig. 5 Circuit diagram for the EPROM card. Links soldered to a DIL header select the correct signals for the various combinations of EPROMs — see Fig. 7 for details.

HOW IT WORKS

PROM CARD
The PROM card is very straightforward as all the hard work is done by the motherboard. ICs 5 and 6 are used to generate A10 and A11 and the $\overline{CS}$ lines. The DIL header plug is used to set jumpers J1-J6 according to requirements (see text).

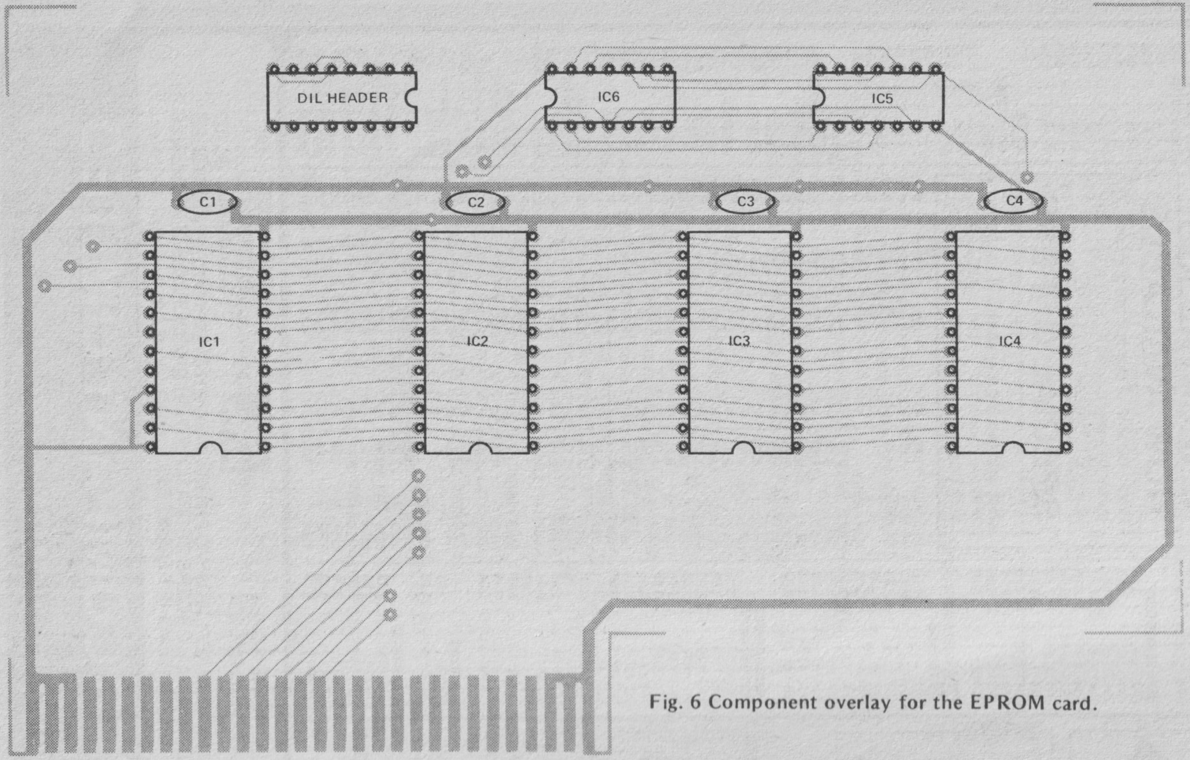


Fig. 6 Component overlay for the EPROM card.

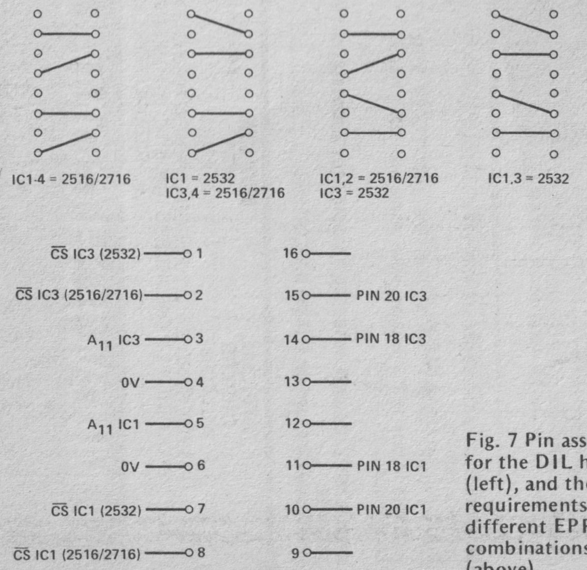


Fig. 7 Pin assignments for the DIL header (left), and the link requirements for the different EPROM combinations (above).

A similar method has been used on the EPROM card. As there are four sets of switches needed for four EPROMs a 16 pin header plug and socket have been used. You can make up a header for four 2516s and two 2532s and easily change the role of the board by simply exchanging header plugs. This retains better flexibility than jumper links and is cheaper than the method previously considered. The DIL header plug can be wired as in Fig. 3.

Refer to Fig. 7 for an explanation of how the header plug is wired.

Construction

Construction of the two boards is very straightforward — follow the overlays given here. Note that if you want to move the card around in memory then simply break the connections $\overline{CS5}$, $\overline{CS6}$ to $\overline{CS2}$ of the 6520 and re-make to the $\overline{CS}$ line you desire.

Use two Veropins or similar to bring the 30 V AC from the transformer to the board — unfortunate as it is using a transformer mounted off the PCB to generate the V_{pp} voltage, it is about the only practical way from a computer that has supply rails of 0 and 5 V.

Fit the 28 pin DIL socket at the IC1 position on the EPROM board. This is to allow experimenters to fit a 2764 8K chip at a later date.

When you have finished you will have a very powerful means of customising your system to your own specifications. To mention one use: you could burn a renumber routine into ROM and then while writing a BASIC program simply renumber by calling the routine through the USR(X) function.

ETI

PARTS LIST

PROM CARD

Capacitors

C1-6	100n ceramic

Semiconductors

IC1-4	2716, 2516, 2532 — PROMs as desired
IC5,6	7408

Miscellaneous

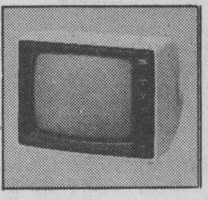
PCB (see Buylines); DIL sockets as required; header plug (see text).

BUYLINES

A complete kit of parts for these expansion cards are available from Watford Electronics. The PROM programmer kit costs £26.95 (PCB only £9.75); the PROM card kit costs £11.95 (PCB only £9.75). All prices are subject to VAT at 15%.

MICROCOMPUTER COMPONENTS AND SYSTEMS
LOWEST PRICES FASTEST DELIVERY

NEC 12" MONITOR



- ★ GREEN DISPLAY
- ★ BUILT IN AMPLIFIER AND SPEAKER
- ★ **£149.95** each excluding carriage (£10.00) and V.A.T. (15%)
- ★ EX-STOCK*

The NEC JB1201M is a 12" Video Monitor optimised for use as a computer video display terminal (unlike most CCTV monitors available). The green phosphor CRT display greatly reduces eyestrain. The built in audio amplifier and speaker make it specially suitable for personal computers.

EPROM PROGRAMMERS AND ERASER

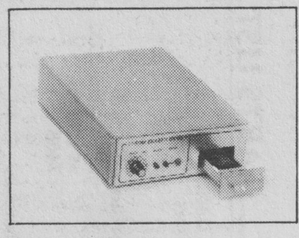
EP4000 EMULATING PROGRAMMER

- ★ COPY/PROGRAMME/EMULATE 2704/2708 2716/2508/2516/2532/2732 EPROMS
- ★ 4K x 8 STATIC RAM
- ★ VIDEO O/P AND 8 DIGIT LED DISPLAY
- ★ POWERFUL EDITING FACILITIES
- ★ COMPREHENSIVE I/O AS STD (RS232, TTL, 20mA PARALLEL, DMA)
- ★ **£545.00** excluding carriage (£10.00) and V.A.T. (15%)
- ★ EX-STOCK*

P4000 PRODUCTION PROGRAMMER

- ★ PROGRAMME UP TO 8 EPROMS SIMULTANEOUSLY
- ★ COVERS SAME EPROMS AS EP4000
- ★ INDEPENDANT BLANK CHECK/VERIFY PROGRAM MODES
- ★ SIMPLE TO USE
- ★ **£545.00** excluding carriage (£10.00) and V.A.T. (15%)
- ★ EX-STOCK*

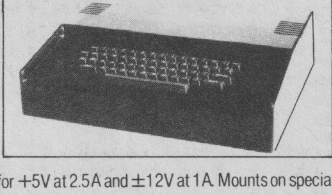
UV141 EPROM ERASER



- ★ 14 EPROM CAPACITY
- ★ SAFETY INTERLOCKED
- ★ ELECTRONIC TIMER
- ★ **£78.00** excluding Carriage (£5.00) and V.A.T. (15%)
- ★ EX-STOCK*

KEYBOARD AND ENCLOSURE

CASE Attractively styled personal computer enclosure constructed of structured foam top and steel base (similar to the top selling Apple). Finished in charcoal and black.
£49.95 excluding carriage (£10.00) and V.A.T. (15%)



KEYBOARD High quality electromechanical ASCII Encoded keyboard which can be fitted in above case or used separately. Full upper and lower case provided.
£49.95 excluding carriage (£2.00) and V.A.T. (15%).

TRANSFORMER Mains transformer suitable for +5V at 2.5A and ±12V at 1A. Mounts on special lugs inside enclosure.
£10.95 excluding carriage (£1.00) & V.A.T. (15%)

HEATSINK Heatsink for T03 Regulators which mounts inside rear of enclose.
£2.50 excluding V.A.T. (15%)

SPECIAL PRICE FOR CASE, KEYBOARD, TRANSFORMER & HEATSINK IF PURCHASED TOGETHER:
£99.95 excluding carriage (£15.00) & V.A.T. (15%)

Device	Price
MEMORIES	
2114L-200ns	1+0.93
	25+0.89
2114L-300ns GTE	1.55
(FOR ACORN ATOM)	
2708 450ns	1+2.25
	25+1.99
2716 450ns	1+2.49
(single +5V)	25+2.25
2716 350ns	6.95
2532 450ns	1+4.50
	25+4.25
2732 450ns	1+3.99
	25+3.80
2732 350ns	7.50
4116 200ns	1+0.74
	25+0.70
	100+0.67
4116 150ns	1+0.93
	25+0.89
4118 200ns	1+3.90
	25+3.45
4118 150ns	6.00
5516 200ns	12.50
6116 200ns	7.95
6116LP 200ns	10.00
6116LP 150ns	10.85
CRT CONTROLLERS	
EF6845P	9.50
EF9364P	5.94
EF9365P	62.90
EF9366P	62.90
EF9365/6 DATA AND APPLICATIONS	2.00
BUFFERS	
81LS95	0.90
81LS96	0.90
81LS97	0.90
81LS98	0.90
8T26A	0.99
8T28A	1.40
8T95	1.35
8T97A	1.35
8T98	1.45
DATA CONVERTERS	
ZN425E-8	3.45
ZN426E-8	3.00
ZN427E-8	5.99
ZN428E-8	4.75
ZN429E-8	2.10
ZN432CJ-10	28.09
ZN433CJ-10	2.59
ZN440	56.63
ZN432E-10	14.75
ZN447	9.14
ZN448	6.85
ZN449	3.20
NEW FLOPPY DISC CONTROLLERS	
FD1771	17.12
FD1791	32.61
FD1793	32.61
FD1795	35.33
WD1391	45.50
WD1393	45.50
WD1395	45.50
WD1397	45.50
WD2143-01	5.45
WD1691	10.87
MISCELLANEOUS SUPPORT CHIPS	
AY-3-1015	3.25
AY-3-1270	7.95
AY-3-8910	6.95
AY-5-1013	3.45
AY-5-3600	7.95
AY-5-2376	6.95
DP8304	4.50
MC1488	0.59
MC1489	0.59
MC3446	2.95
MC3448A	4.25
MC3480	7.95
MC3487	2.95
MC14411	6.94
MC14412	7.99
RO-3-2513L	6.99
RO-3-2513U	5.99
ULN2803A(L203)	0.84
DVM CHIPS	
ZN450e	7.61
ZN450E DVM KIT	25.00
NEW LINEARS	
LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.20
LM324N	0.30
LM348N	0.59

Device	Price
LM555CN	0.16
LM556CN	0.49
LM725CN	3.20
LM741CN	0.14
LM747CN	0.70
LM748CN	0.34
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
79L05	0.59
79L12	0.59
79L15	0.59
LM309K	0.99
LM317K	3.20
LM323K	4.95
LM338K	4.75
Z80 FAMILY	
Z80 CPU	3.49
Z80A CPU	3.99
Z80 CTC	2.99
Z80A CTC	2.99
Z80 DART	10.00
Z80A DART	12.00
Z80 DMA	9.95
Z80A DMA	11.95
Z80 PIO	3.49
Z80A PIO	3.75
Z80 SIO-0	10.99
Z80A SIO-0	11.99
Z80 SIO-1	10.99
Z80A SIO-1	11.99
Z80 SIO-2	10.99
Z80A SIO-2	11.99
MK 3886	11.00
MK 3886-4	14.47
6800 FAMILY	
6800	2.99
6802	3.99
6803C	11.80
6809	9.99
6810	1.25
6821	1.25
6840	4.20
6850	1.50
6862	6.91
6871AIT	18.70
6880	1.07
6887	0.80
68488	9.11
6875	4.18
6843	13.99
68B00	4.70
68B02	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.15
68000C4	110.00
6500 FAMILY	
6502	4.25
6520	2.99
6522	4.75
6532	6.95
8080 FAMILY	
8085A	5.50
8212	1.70
8216	0.99
8224	1.95
8228	3.95
8251	3.60
8253	7.95
8255	3.60

Device	Price
CMOS 4000 'B' SERIES	
4000	0.11
4001	0.11
4002	0.13
4006	0.60
4007	0.15
4008	0.55
4009	0.28
4010	0.35
4011	0.12
4012	0.15
4013	0.29
4014	0.58
4015	0.58
4016	0.25
4017	0.45
4018	0.58
4019	0.29
4020	0.58
4021	0.60
4022	0.62
4023	0.17
4024	0.35
4025	0.16
4026	0.99
4027	0.30
4028	0.55
4031	1.65
4033	1.60
4034	1.55
4035	0.72
4040	0.54
4041	0.69
4042	0.54
4043	0.59
4044	0.64
4045	1.65
4046	0.68
4047	0.68
4048	0.54
4049	0.26
4050	0.26
4051	0.59
4052	0.68
4053	0.59
4054	1.20
4055	1.20
4060	0.79
4063	0.95
4066	0.34
4068	0.17
4069	0.17
4070	0.17
4071	0.17
4072	0.17
4073	0.19
4075	0.17
4076	0.62
4077	0.22
4078	0.24
4081	0.14
4082	0.19
4085	0.63
4086	0.69
4093	0.39
4502	0.69
4507	0.39
4508	1.90
4510	0.60
4511	0.49
4512	0.60
4514	1.49
4515	1.49
4516	0.69
4518	0.40
4519	0.28
4520	0.69
4521	1.49
4522	1.20
4526	0.70
4527	0.89
4528	0.70
4532	0.85
4541	0.99

Device	Price
4543	0.99
4553	2.90
4555	0.39
4556	0.44
4585	0.62
74LS SERIES	
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74LS01	0.11
74LS02	0.12
74LS03	0.12
74LS04	0.12
74LS05	0.13
74LS08	0.12
74LS09	0.12
74LS10	0.12
74LS11	0.12
74LS12	0.12
74LS13	0.22
74LS14	0.39
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS26	0.15
74LS27	0.12
74LS28	0.15
74LS30	0.12
74LS32	0.12
74LS33	0.16
74LS37	0.15
4LS38	0.15
74LS40	0.12
74LS42	0.34
74LS47	0.39
74LS48	0.60
74LS49	0.59
74LS51	0.14
74LS54	0.15
74LS55	0.15
74LS73	0.19
74LS74	0.16
74LS75	0.24
74LS76	0.20
74LS78	0.19
74LS83	0.44
74LS85	0.65
74LS86	0.15
74LS90	0.30
74LS91	0.75
74LS92	0.34
74LS93	0.34
74LS95	0.43
74LS109	0.21
74LS112	0.21
74LS113	0.23
74LS114	0.19
74LS122	0.39
74LS123	0.39
74LS124	0.99
74LS125	0.25
74LS126	0.25
74LS132	0.45
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74LS139	0.35
74LS145	0.75
74LS148	0.90
74LS151	0.39
74LS153	0.29
74LS155	0.39
74LS156	0.38
74LS157	0.31
74LS158	0.31
74LS160	0.39
74LS161	0.39
74LS162	0.39
74LS163	0.39
74LS164	0.47
74LS165	0.99
74LS166	0.84
74LS173	0.70
74LS174	0.47
74LS175	0.49
74LS181	1.28

Device	Price
74LS190	0.49
74LS191	0.49
74LS192	0.49
74LS193	0.46
74LS194	0.39
74LS195	0.39
74LS196	0.59
74LS197	0.65
74LS221	0.54
74LS240	0.89
74LS241	0.89
74LS242	0.79
74LS243	0.79
74LS244	0.65
74LS245	0.89
74LS247	0.63
74LS248	0.63
74LS249	0.63
74LS251	0.40
74LS253	0.39
74LS257	0.40
74LS258	0.39
74LS259	0.79
74LS261	1.95
74LS266	0.23
74LS273	0.75
74LS279	0.39
74LS283	0.44
74LS290	0.54
74LS293	0.45
74LS365	0.34
74LS366	0.36
74LS367	0.34
74LS368	0.49
74LS373	0.74
74LS374	0.74
74LS375	0.47
74LS377	0.89
74LS378	0.69
74LS379	0.64
74LS386	0.28
74LS390	0.54
74LS393	0.59
DIL SOCKETS LOW PROFILE - TIN	
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14 pin	0.09
16 pin	0.09
18 pin	0.13
20 pin	0.14
22 pin	0.17
24 pin	0.19
28 pin	0.25
40 pin	0.29
NEW LOW PROFILE - GOLD	
8 pin	0.22
14 pin	0.29
16 pin	0.31
18 pin	0.33
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22 pin	0.40
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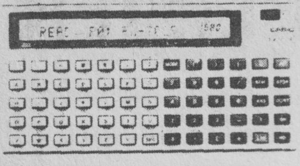

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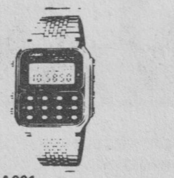

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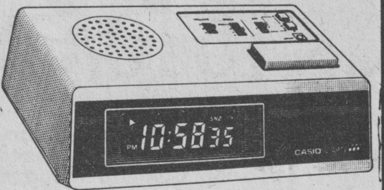

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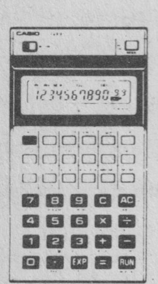

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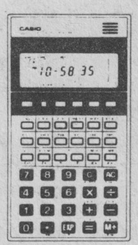

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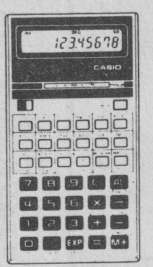

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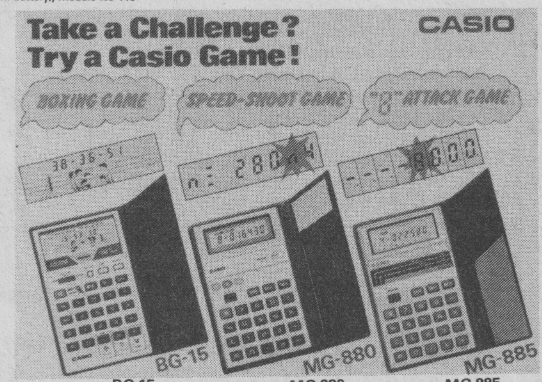

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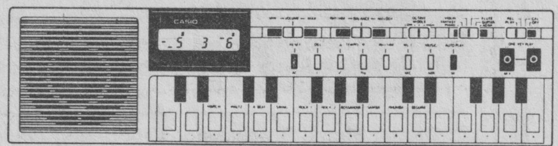

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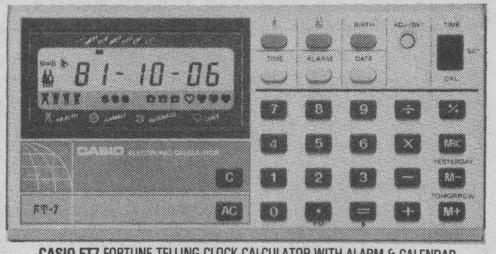

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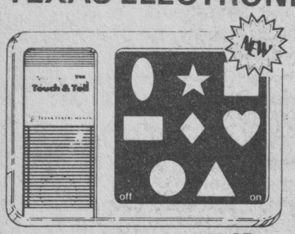

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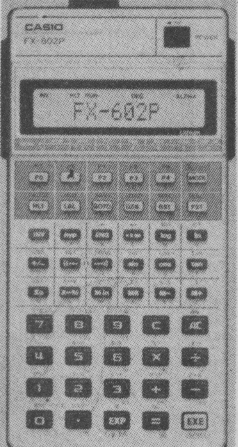

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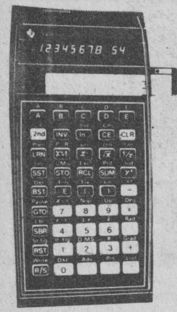

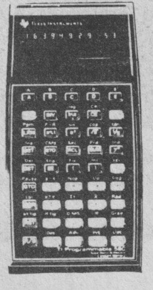

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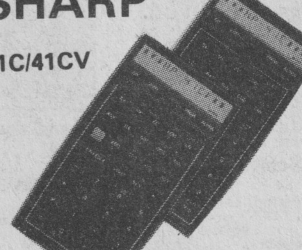

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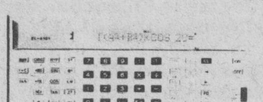

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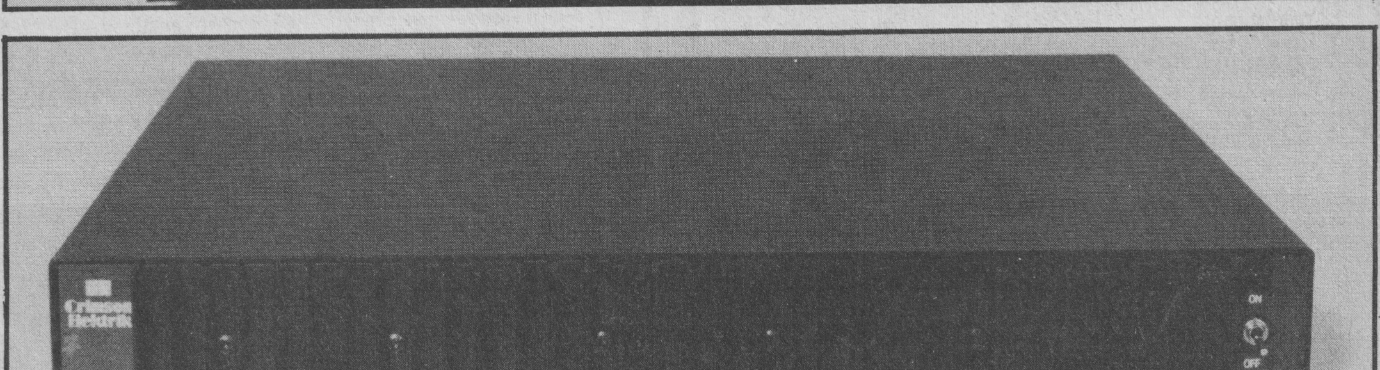
4. **The judges' decision is to be considered final and no correspondence will be entered into concerning the competition.**



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New amplifier boards to meet new needs

New Signals

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The PFA/HV

Ths four powerfet module is designed to run from supply rails up to $\pm$ 100V. Rated at **300W continuous** RMS into 4 and 8 ohms and **250W** into 16 ohms, the module can sustain, for musically significant periods of time, RMS powers of **500W** into 8 ohms and **900W** into 4 ohms. It also has the ability to drive 70V line distribution systems directly, obviating the need for expensive and quality compromising transformers.

This amp is designed particularly with music in mind. We anticipate usage often at only 50W to 100W average levels leaving 10dB of headroom.

PFA 500

This module uses 8 H-PAK powerfets and is designed to produce a continuous RMS output current of **25 amps** and will run from a supply of up to $\pm$ 70 volts. The Unit will drive **250W** continuous RMS into 8 ohms, **450W** into 4 ohms, **600W** into 2 ohms and **700W** into 1 ohm.

Numerous features are included in the board to optimise efficiency. The H-Paks (thermally more efficient than TO3) are presented at ninety degrees to the P.C.B. so they can bolt directly onto the heatsink, instead of via the usual angle bracket. The resultant chip to heatsink thermal resistance is very low keeping junction temperatures down and efficiencies up. The Powerfet supply rails are kept separate from the rest of the amp. This enables the driver stage to be run from slightly higher rails resulting in larger undistorted output swings at little extra cost.

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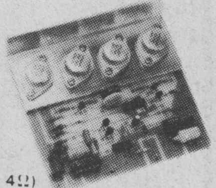

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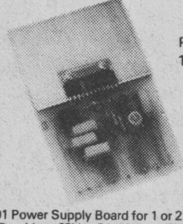
The components used in the PFA have been chosen with extreme care The lowest noise input devices and lowest distortion gain stage devices were selected regardless of cost 140V powerfets were chosen against the more usual 120V to give improved safety margins

Specification	PFA80	PFA120	
Bandwith	10hz	100KHz 1dB	
Output Power R M S into 8Ω	80W (Vs = ± 50V)	120W (Vs = ± 55V)	
THD (20Hz 20KHz)	≤0 008%	≤0 005%	
(KHz at rated output)	0 004% typ	0 002% typ	
SNR	120dB		
Slew Rate	>20V µS		
Gain	X22		
Rin	30K		
Vs max	± 70V		
Cost			
(built)	£17.45	£24.85	P. & P. 75p
(kit)	£14.95	£21.85	

Power Amp PAN 1397

A high quality 20W power amp board based on the HA1397 Easily modified for bridge operation providing high powers from low supply voltages

Specification	
Output power RMS	20W into 8Ω at · 22V
	20W into 4Ω at · 19V
THD	0 02% at 1KHz 1W to 12W
SNR	90dB
Input	100mV into 50K
Cost (Built)	£5.80 (P. & P. 40p)



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Specification	
B W	20Hz-30KHz ± 1dB
THD at rated o/p	0.003% typ.
SNR	85 dB (ref. 5mV RIAA)
	105 dB (ref. 100mV flat)
Vs	± 20V
Output	1V (clips at + 20dB)
Cost (built board less controls)	£6.75 2 needed for stereo (P. & P. 40p)

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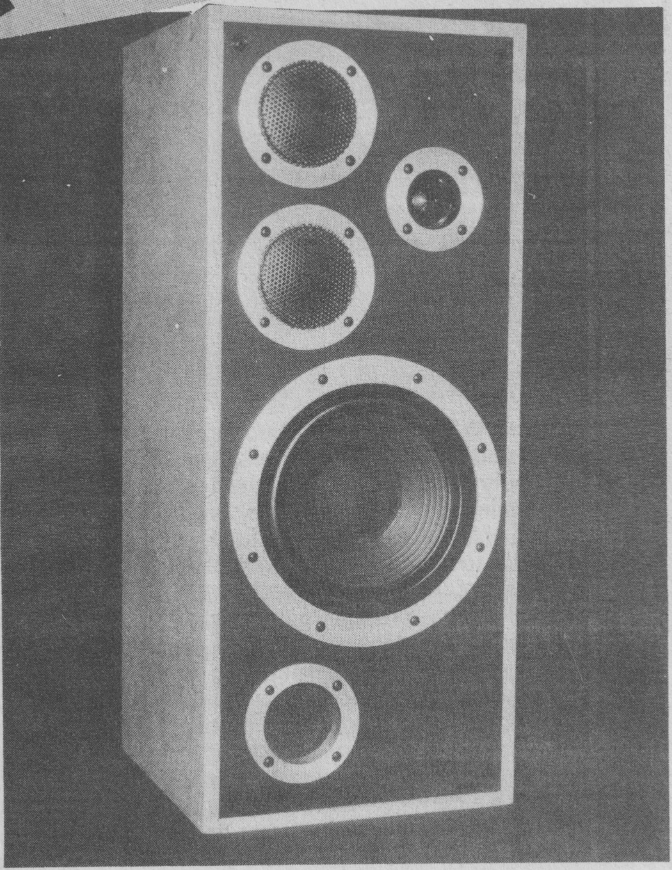
KIT REVIEW

Fancy a pair of Wharfedale E70s? Can't afford them? Then why not build 'em yourself? Peter Freebrey underwent the mystic rites of woodworking and saved himself over £100.



For many years now there have been speaker manufacturers who have marketed kits for the 'do-it-yourself' audio enthusiast. At the present time there are several well known and respected firms supplying high quality kits. One such firm is Rank Hi Fi who manufacture the Wharfedale range. Their approach to this market is the Wharfedale Speakercraft series of drive units and crossovers, together with the constructional information necessary to duplicate their ready-built units using these same components. If the demand is there someone will supply that demand . . . such is the case with Wilmslow Audio who sell kits of the cabinets to suit the Wharfedale units. This review follows the construction of the E70 system using the WE70 flat-pack cabinet kit.

Why build loudspeaker kits? Well, one obvious answer is to save money; often the cost of a kit is very much less than buying the completed unit. If you are reasonably competent at woodwork, it is perfectly feasible to start from scratch with just a large sheet of flooring grade ¾" chipboard. An electric power saw makes the job much easier and can also give a better edge to the cut. It is often the edges which concern people as they are going to be visible somewhere around the loudspeaker cabinet and it is easy to think that to get rid of the ugly sight of these will be difficult. This is not necessarily true; there are several ways in which unsightly edges may be hidden from view. The simplest answer is not only to buy a kit of speakers, crossovers, and so on, but perhaps to buy a ready-cut cabinet kit as well — this does not rid you of dealing with edges, but at least they are all cleanly cut!

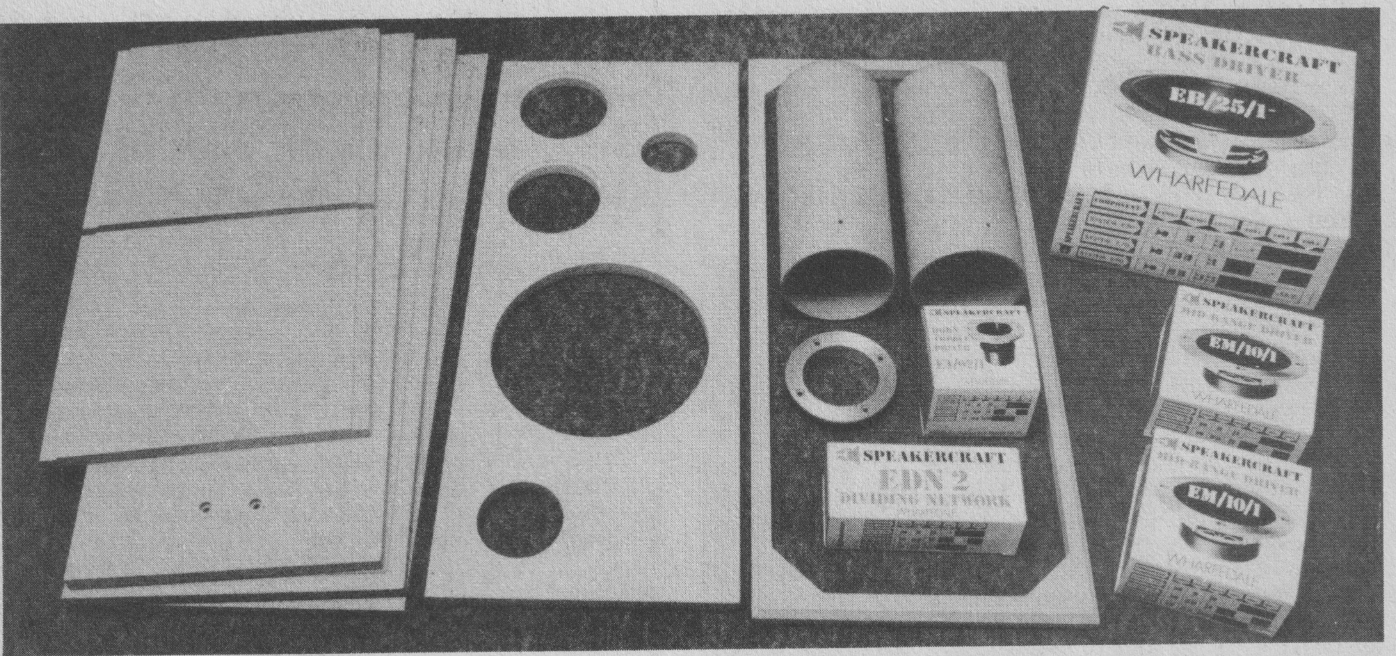
I had heard that Wilmslow kits were of a very high standard — several people having commented upon the ease with which they went together. That sort of build-up sometimes takes a bit of living up to and I waited for the delivery of the WE70 kit with some uncertainty. When they arrived my initial reaction was favourable; all cuts were clean and the method of construction looked simple and sensible. The sides, top and base are rebated by about ⅛". This not only gives you a better mechanical joint, but also makes it almost impossible to get any voids or gaps — which is good, acoustically speaking. It also means that with the minimum of care the cabinet will slot together into its correct shape with no unsquare corners or leaning sides. Included with the kit were two cardboard transmission tubes for the mid-range units, acoustic damping material, grille material (both black plastic foam for the reflex port and cloth for the front), nylon grille plugs and sockets, 3 mm wander plugs and sockets for loudspeaker lead connections, and the screws to fix the speaker units themselves. Last but not least there are written instructions on how to assemble the kit.

16 Steps To Heaven

Step one in the instructions is to examine the panels for transit damage. Presumably if any damage is noticed, Wilmslow Audio should be contacted as soon as possible. Step two is to remove all dust, etc from the panels. Any excess of wood dust from the sawing operation can only do harm so vacuum all surfaces. If there were any build-up of sawdust at the surfaces to be glued that sawdust could conceivably impair any glue joints and also cause the fit of the joints to be out of true.

Step three is to assemble the cabinet without gluing to check the fit. It is also suggested that panels be swapped around to find the optimum results. This step proved to be most encouraging . . . I assembled one unit (panels only) and held it together with just one turn of linen tape (no string please — it can bite into the corners of the chipboard and cause you extra work later). The cabinet felt as firm as a rock. No glue, just well-fitting joints. Thus encouraged I rapidly got on to step four, which was to paint the face of the baffle board matt black. I gave it a couple of coats of sanding sealer — not so much to get a 'de luxe' finish but to seal the wood surface. Chipboard is pretty thirsty stuff and you can use up a lot of paint if you do not seal the surface first. Just be careful not to get any of the sealer or paint on the edges, as this may affect the glue joint you have to make later.

Step five is to glue the midrange enclosures (transmission tubes) to the baffle boards, using plenty of glue to ensure an air-tight seal. The baffle boards are recessed to take the cardboard tubes so it is easy to line up for position. I used Evostik Resin W, which is a PVA wood-working adhesive for all glue joints. It is easy to apply and may be cleaned off the hands/clothes as it is water soluble. Just don't put your speakers out in the rain! Light pressure to a PVA glued joint gives a better joint so I placed one of the side panels across the top of the four tubes to ensure a light even pressure. Rather than apply liberal amounts of glue in one dose I used sufficient so that a *small* bead of glue was squeezed out all around the tube. This was smoothed around with a handy finger and when dry a further fillet of glue was applied all round the tube/baffle joint. Four pieces of approximately 1" thick polyurethane foam are supplied which must be ➧



glued to the rear (outside) end of the baffle tubes. Wharfedale recommend a hard rubber pad at this position but as this 1″ foam is to be compressed to about 3/16″ it probably is just as good.

Step six is probably the most critical point in the whole construction procedure, for at this point the cabinet panels are glued together. This entails gluing five of the six panels; the sixth (the side furthest from the mid-range enclosures) is placed in its position while the glue is setting but is not glued. This enables you to work inside the cabinet; fitting the crossover, acoustic wadding etc.

Wharfedale suggest that the acoustic wadding be attached to the inside of the panels before you reach this step. Wilmslow Audio suggest that the wadding be fixed *after* the panels have been glued. Although I only learnt of Wharfedales' suggestion after I had completed step six, I favour the Wilmslow approach for several reasons.

If the wadding is stuck/tacked or stapled to the panels before they are fitted together two things may happen: 1) some of the wadding may inadvertantly get caught between the panels and cause either an air gap or 2) force the cabinet to go together 'out of true'. Also, with the wadding in place you cannot inspect the inside corners to check that there is a continuous fillet of glue all along the joint.

If you choose the Wilmslow way you will have to cut the wadding to fit around the mid-range enclosures but in practice this proved to be a very simple task.

Getting A Grip

Holding the whole thing together while the glue sets is quite a teaser. I was fortunate to have a set of excellent clamps known as Jet System Clamps made by TMT Design Ltd of Leamington Spa. They cost about £10 per clamp but are worth their weight in gold for this type of job. The problem comes from the 1″ thick foam stuck to the rear of the mid-range enclosures; this tends to force the back panel out of position. Wilmslow suggest either that clamps be used or that the joints be held *firmly* together with masking tape. It *is* possible with masking tape but only just; remember that unlike your trial fitting in step three, the foam pads are being compressed to about 3/16″ and all but one panel has glue all along the edges and is quite capable of sliding all over the place! I bought a wide webbing strap from a camping shop to assist the initial stages of holding the four vertical panels approximately in place while I set up the clamps. The cost of the strap was wasted as I could not get enough tension in it to overcome the spring in the foam . . . a linen tape would have done just as well! If you are going to use masking tape then get someone to help apply the pressure to hold the front and back panels in position while you apply the tape. Lastly, cut up a thin polythene bag and place four pieces inside each corner of the panel that is not to be glued; it would be a shame if this stuck firmly to the rest of the panels by accident!

It is useful to have a rubber-faced hammer at this stage as, having clamped or taped the cabinet firmly together, you may wish to tap the panels firmly but lightly into position. A hammer *and* a block of wood do the trick just as well, but try not to mark or dent any edges. The places to look for out of true joints are the corners . . . remember once the glue has set there is nothing you can do, so a few light taps now can save the day. Wipe off excess glue with a damp cloth. Wipe from the centre of each panel *out* towards the edge; try not to get any glue smeared over the panels.

Having completed step six the rest of the construction is plain sailing. Step seven is simply to remove the loose side when the glue has set (leave for at least 24 hours). I then put a small fillet of glue all around the inside of all joints BUT not up to the edges where the last panel is to fit . . . we want it to go back from whence it came!

Step eight is to place the drive units and reflex port trims in the baffle board and mark accurately where pilot holes for the fixing screws are to be drilled. Although the chipboard is high density it has a fairly soft texture so it is well worth buying a new ⅛″ drill bit. This ensures the pilot holes are clean and in the right place . . . worn bits tend to wander! Although I'm sure it is unnecessary I drilled all my pilot holes just deep enough for the screws by slipping a small rubber sleeve over the drill bit at the right depth. No-one could accuse me of having any extra holes or air gaps here!

Step nine is to position the grille frame on the front of the cabinet with the cabinet lying on its back. Use masking tape to hold it in position and carefully drill a pilot hole through the grille and into the baffle board. I used a 1/16″ drill bit and drilled four holes, one in each corner section of the grille frame. These holes can now be drilled out to the correct size to accept the nylon plugs and sockets that hold the grille in place. Wilmslow supply eight plugs/sockets for each grille but as Wharfedale suggested that four would be sufficient I chose the latter. It is far easier to line up four holes than eight! For the socket in the baffle board I used a 7/16″ bit and for the grille a 7/32″ bit. Don't forget to drill only from the rear of the grille and only to a depth of ¼-5/16″. The 1/16″ pilot hole may be filled with wood filler

but when the grille material is fitted I doubt that these holes can be seen. If you are happy with the finish on the baffle board then glue the sockets in now; if not, then wait until you have quite finished before fixing them in position. Do not stick the plugs in the grille until you have fixed the material in place. I used a quickset epoxy glue for these fittings.

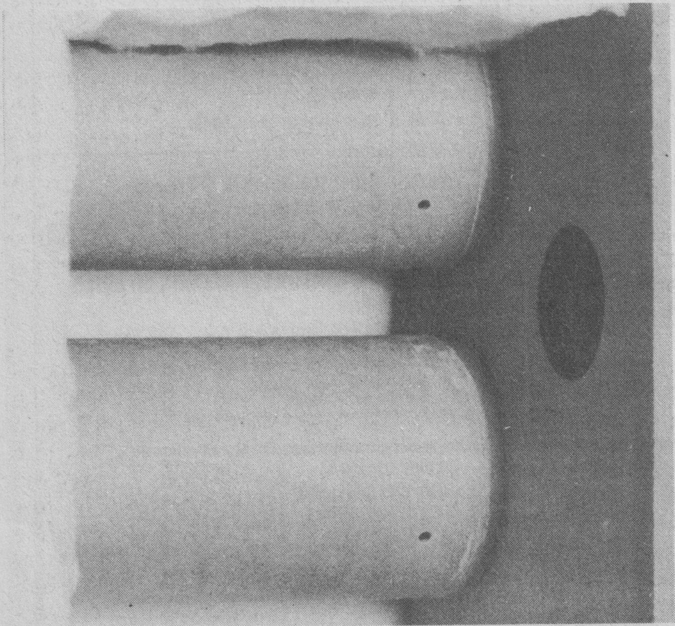
Step 10 is to glue the black, acoustically transparent foam over the inside of the reflex port aperture. You can use either PVA glue or quickset epoxy, just be careful not to get any of the adhesive on the foam where it is over the port.

Step 11 is to position the crossover network inside the cabinet on the rear panel opposite the bass unit aperture. Before you screw it into position check that the leads from the drive units can reach their appropriate tags! Wharfedale recommend that the crossover has a piece of felt or foam between it and the panel to prevent any vibration rattles. Also in step 11 is the fitting of the input terminals through the rear panel. I smeared the threads on these sockets with some latex glue, again to ensure that there would be no air gaps. Solder the leads from the crossover to these terminals . . . make sure they are connected correctly, red to red and black to black!

Step 12 is to cut three 5″ discs of wadding and place these in the mid-range tubes. The Wharfedale instructions that come with every Speakercraft unit specify that the packing density of this wadding should increase towards the back of the tube and that the tube should be completely filled with wadding. In view of this I cut two extra discs and fluffed out those towards the front of the tube.

It's In The Bag

Step 13 is to line the inside of the cabinet with the acoustic wadding and glue the remaining side into place. Now comes the tricky bit — how do you slide the wadding up behind the mid-range tubes? The wadding catches on the side panel and snags up behind the tubes! Easy — get a large polythene bag 12″ or more wide and about 15″ to 18″ long, slide the wadding into the bag, slide the bag plus the wadding up behind the tubes and, lightly holding the wadding in place, pull out the bag. Cutting the wadding to fit round the tubes sounds fiddly but turned out to be quite easy. Cut the holes for the tubes smaller rather than larger as the wadding will easily stretch to fit comfortably in place. No wadding is required on the baffle board but don't forget to put wadding on the loose side panel before you glue it into place! The wadding may be tacked or stapled into place.



The wadding is tacked or stapled in place.

Step 14 is to attach the wires to the drive units — *observing the correct polarity* (if in doubt refer to the Speakercraft instructions and double-check every connection), and screw all units and ports to the cabinet. Wire up and fit the bass unit last as the bass aperture gives you ample room to work inside the cabinet connecting wires to the crossover. The wires from the mid-range units come through small holes in the tubes and these holes should be sealed after you have connected the wires to the crossover. The fitting of the drive units should only be started after the glue joints of the final side have thoroughly set and any glue fumes have completely cleared. The comment regarding fumes is highly pertinent if you are not using a water-based adhesive. There is a possibility that the fumes could affect certain plastics used in the construction of the drive units.

Step 15: You have two working loudspeaker systems, so connect them to your amplifier and sit back and enjoy your favourite record.

Step 16: The cabinets are now ready for their final cosmetic treatment. There are a number of options open to you: they may be:

- veneered either by you or a local cabinet-maker.
- covered in iron-on veneer or plastic laminate.
- sealed and then painted (preferably sprayed) in colour of your choice.
- Wilmslow Audio also suggest the use of a 'Contact' type covering as these can be obtained in very realistic wood-grain finishes.

Whichever method you opt for you will probably have to attend to the cabinet edges/joints before you can proceed. Due to the small but noticeable tolerances in the cutting of the panels, the amount of glue and the pressure used during the construction, there are likely to be a few panels that are slightly proud of the edges that butt up to them. There are several ways to solve these problems but the simplest is to use one of the proprietary wood fillers. Which choice depends upon your choice of finish.

If the cabinets are to be covered in plastic laminate you can afford to use one of the more easily worked fillers such as Fine Surface Polyfilla, Alabastine or Plaster of Paris. If, on the other hand, you are going to cover them with 'Contact' or simply spray-paint them then I would suggest a tougher type of filler that is less likely to crack or crumble. My choice here would be one of the car body fillers — they are easier to sand than some of the loaded general-purpose fillers from the DIY shop. So you are less likely to sand away the wood from the cabinet instead of the filler!

The grille material must be stretched over the grille frames and either tacked/stapled or glued (or both) to the inside of the frame. The material supplied by Wilmslow Audio stretched easily and evenly; I smeared PVA glue over the rear faces of the frames (having first painted them black) and stapled the material in place while the glue set. When set I trimmed off the excess material (having removed the 50-odd staples) and ran another bead of the adhesive over the edge of the material.

Looking back on the construction of this E70 loudspeaker system using the WE70 flat-packs, I can only say that I am very satisfied with the way they went together. There were one or two instructions that could have been a little clearer but they have been covered in this article. Common sense would probably have solved any uncertainties but I chose to phone Rank Hi Fi to confirm my conclusions. The people I spoke to did not know that I was writing this review and so it is a pleasure to say the they could not have been more helpful. This entire project has been enjoyable from first to last.

BUYLINES

Wilmslow Audio sell the complete WE70 package (flat pack, drivers and all components for two speakers) for £220 plus £8 carriage. Wilmslow Audio, 35/39 Church Street, Wilmslow, Cheshire SK9 1AS.

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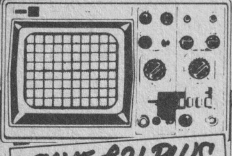

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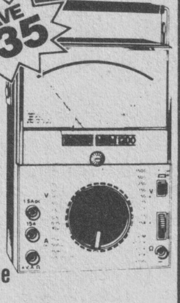

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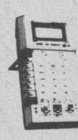

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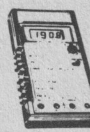

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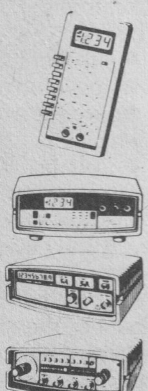

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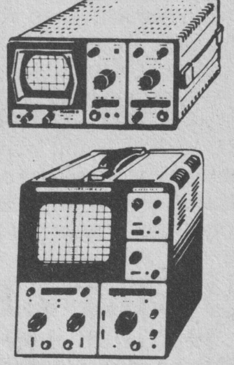

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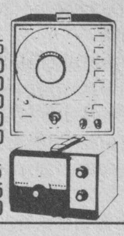

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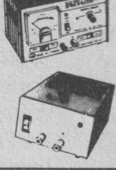

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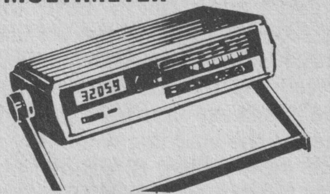

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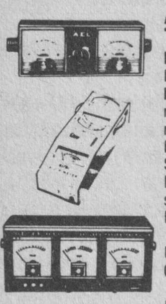

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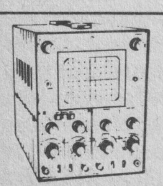

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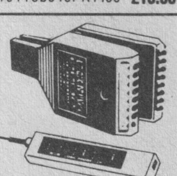

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AUTOMATIC CONTRAST METER

What's black and white and read all over? Answer — a photographic negative, providing you've built this simple and useful device. Design and development by Rory Holmes.

Contrast ratio is a very important quality of photographic negatives that must be assessed during the printing process, in order to select the correct grade of photographic paper. The contrast of negatives depends on the type of film used, the lighting conditions and the developing process; consequently five grades of printing paper are available to enable the full range of tones from black to white to be reproduced from any negative. Grade 1 is termed the softest and it is used with the highest contrast negatives. At the other end of the scale, grade 5 is the hardest paper, which will enhance the tonal variations of poor contrast negatives.

During the design stage of this project we experimented initially with two separate photodetectors which measured the instantaneous light difference between two points. There are a number of problems with this approach, as the photodiodes and their associated amplifiers must be carefully matched in light sensitivity.

Secondly, the lightest and darkest points of the image must be known exactly, and the two photodetectors need to be simultaneously positioned on these points while the reading is taken. This is an awkward business at the best of times, but especially so in a darkroom!

We considered that a different approach was required and developed the circuit of Fig. 1 to overcome some of these difficulties. Only one photodetector is used and the peak positive and negative voltages obtained from different light levels are followed and stored independently by sample and hold circuits.

Now, as long as the photodiode is scanned at some time through the lightest and darkest points of the image, the peak detectors will memorize the maximum and minimum voltages, and thus provide a contrast measurement.

The photodetector input stage of our meter is rather unusual in its configuration. Photodiodes are usually

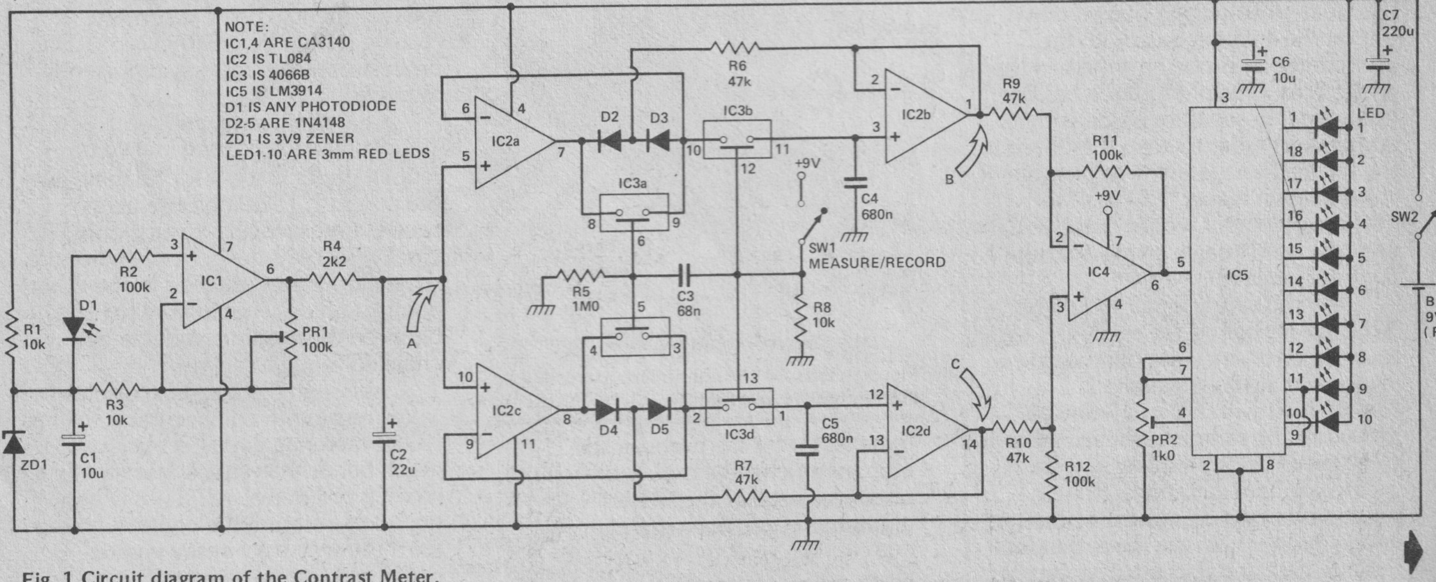


Fig. 1 Circuit diagram of the Contrast Meter.

used in the 'photovoltaic mode' where the photocurrent developed and measured is linearly proportional to the light intensity. Our input amplifier has an extremely high input impedance and thus measures the open circuit voltage generated by the photodiode. This voltage is logarithmically proportional to irradiance as the graph of Fig. 2 illustrates. This is a very convenient property since the sampling circuitry can now work on the log of the light level to provide maximum and minimum values. By simply subtracting these two values with a differential amplifier we obtain a voltage that is logarithmically proportional to the ratio of the maximum and minimum light levels, ie the contrast.

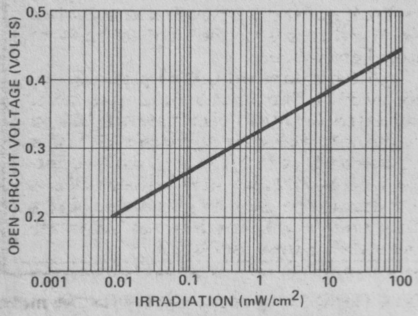


Fig. 2 Response of the photodiode used in this project.

Meter Made

The ETI contrast meter was intended primarily to determine the paper grade for a well balanced print; consequently a 10 LED bargraph type meter is sufficiently accurate for calibrating the five grades of paper. At today's prices this also works out somewhat cheaper than a moving coil meter and is less prone to damage. After calibration, the meter will be found very easy to use. It is switched on with the 'sample/hold' switch in the 'hold' position and placed down flat on the enlarger base with the photodetector probe anywhere in the image area. (The photodiode has been mounted in a separate probe with its amplifier in order to keep it as close to the focused image plane as possible. If it were much higher than this the detecting element would pass through an unfocused image, giving a false contrast reading).

Any red safety lights should be switched off before the reading is taken to avoid error since the photodiode is responsive at this wavelength. The sample/hold switch should now be moved to the sample position; this will clear any previous reading and start measuring light variations. Now the photodiode may be moved across the image and through the areas that look the brightest and darkest. This can be done quite slowly thanks to the peak detectors' long memory time; however, several areas should be scanned to ensure the recording of the true maximum and minimum. The eye can be deceived quite easily by those cunning optical illusions lurking among the shades of grey!

During the scanning process the reading on the LED scale will increase and finally level-off at the true contrast ratio when the black and white peaks have been covered. Before removing the meter from the image area the sample/hold switch should be set to 'hold'. The meter will now be immune to further light variations and will continue to display the contrast reading for a considerable time, thanks to the even longer memory of the sample/hold circuitry!

A true ratio is provided by the meter and thus the contrast reading for a given negative will be independent of the light source intensity and enlargement size (photographic aberrations known as "circles of confusion" may produce sources of error under certain conditions). Negatives may thus be compared or matched for contrast.

Construction

The meter is built into a slim style plastic enclosure produced by OK Machine and Tool company. This houses the battery and main PCB on which all the parts are mounted. Since the light sensing element must be as close to the enlarger base plane as possible, we have mounted it externally on a separate small PCB with its associated amplifier. A probe to house the external sensor is made from a short length of aluminium channel extrusion. Figure 3 shows the dimensions for the probe; if the aluminium channel proves difficult to obtain, a piece of the slotted aluminium extrusion used for commercial shelf-racking systems is ideal. This is available from most DIY stores in short lengths with the required internal width. After filing or cutting to the right size, a piece of insulating tape should be stuck down on the inside to prevent shorting out the PCB. As shown in the diagram, a hole is drilled on the end for bolting it to the bottom of the case. This bolt should eventually be connected to circuit ground, thus providing screening for the photo-amplifier. The two PCBs for probe and main meter circuits are laid out as one board, and should be sawn apart along the lines shown on the foil patterns.

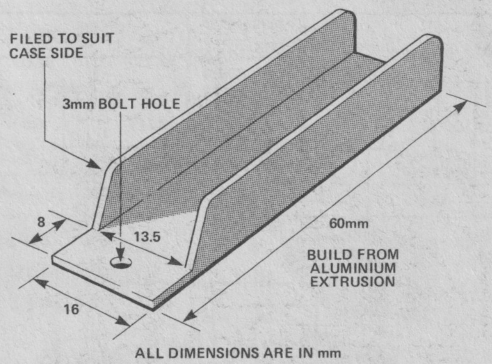


Fig. 3 Details for the aluminium extrusion that houses the photoprobe.

For other construction arrangements, the circuit can be left as a single board, since the interconnections are already made.

Three wires are used to connect the two boards together as indicated on the overlay; these should pass through a small hole drilled in the case side where the metal probe case is bolted on. When the probe board is mounted and stuck down in its channel, a piece of thin aluminium sheet is cut to form a lid with appropriate holes for the photodiode and preset. (The photodiode case is internally connected to the cathode, so it must not short against the lid).

Calibration

Start with preset PR1 fully clockwise to set a gain of 1; also set PR2 fully anticlockwise, setting the voltage required to illuminate the lower end of the bargraph at zero. First, measure a high contrast negative that is known to require grade 1 paper for a good average contrast after developing. Initially a low contrast reading will be obtained, say about grade 4 or 5. Now, adjust PR1 anticlockwise to increase the gain of the photoamplifier. Take another measurement, when the contrast reading should be greater. Repeat this process until a grade 1 is consistently recorded.

Now select a negative with very poor contrast ratio, one known to require paper grade 5 for bringing out the contrast. Take measurements several times while adjusting only PR2 clockwise, until the bottom end of the scale illuminates at grade 5. The other contrast grades should now fall linearly between these points and can be checked for accuracy.

Although the bargraph display has a low resolution and accuracy, the rest of the metering circuit is obviously much better than this; consequently a moving coil meter could easily be added to measure the contrast voltage for those who may desire greater resolution.

HOW IT WORKS

The general circuit arrangement consists of a photo-amplifier which feeds a voltage derived from varying light levels in an enlarger, to a pair of peak detectors. One follows the peak positive voltage and the other the peak negative voltage. The capacitors used for storing the voltage peaks in the followers also form part of sample and hold circuits which are then switched to 'hold' after measurement. Their outputs represent the maximum and minimum values of light intensity. A differential amplifier then computes the ratio of these values and the result is displayed on an LED bargraph meter.

IC1, a CA3140 CMOS op-amp, is used as the photodetector amplifier. It is configured as a non-inverting DC amplifier with a gain variable from unity to about 10, set by PR1. Although IC1 can have input and output voltages all the way to ground, this facility is not used owing to the driving requirement of the TL084 quad op-amp. This requires inputs at least 1 V above ground, and thus IC1's output is offset by a reference voltage of 3V9 provided by R1, ZD1 and C1. The anode of the photodiode is connected via R2 to the non-inverting terminal of IC1 which has an effectively infinite input impedance. Thus the open circuit voltage generated by the photodiode is amplified according to the gain set around IC1 and appears at the output on pin 6 added to the reference voltage.

The voltage at point A (ignoring the reference offset) will be logarithmically proportional to the intensity of incident light, owing to the properties of the photodiode (see Fig. 2) R4 and C2 form a simple filter to remove 100 Hz ripple caused by AC mains bulbs. This voltage is fed directly to the peak detectors. These circuits are essentially the same, the difference being the polarity of the rectifier diodes. They operate in exactly the same way, and we shall deal only with the peak positive voltage follower.

Assume initially that the CMOS analogue switch IC3c is open and IC3d is closed. C5 will be connected to the output of op-amp IC2c via the rectifiers D4 and 5 (we can ignore the action of R7 for the moment). C5 will charge up via the rectifiers to the most positive voltage peak when the voltage at point A on the non-inverting terminal is greater than the capacitor voltage applied to the inverting terminal. The voltage held on C5 will droop over a period of time due to leakage current through the rectifiers D4 and 5 and the input bias current of IC2c. IC2c was chosen as a FET op-amp with a low input bias current and R7 is included to reduce the diode leakage current.

IC2d is connected to C5 as a straightforward high impedance voltage follower to buffer the stored voltage. When the input voltage to IC2c at point A drops below the peak value, IC2c's output will go negative, reverse biasing D4. However, IC2d applies the capacitor voltage via R7 to the anode of D5, effectively removing leakage current through D5.

The peak positive value of the signal at A thus appears at point C, and likewise the peak negative value at point B. When the analogue switch IC3d is now opened, C5 is disconnected from the peak detector and acts in conjunction with IC2d as a sample and hold circuit thus isolating the measured values from further light variations.

When SW1 is open, R8 and R5 hold the control pins 13 and 5 of IC3 low, opening both analogue switches. This is the 'hold' mode. When SW1 is now closed, the control pin 13 is taken high, switching to the 'sample' mode. C3 and R5 produce a positive pulse (about 50 mS) on control pin 5 to briefly short out D4 and D5, so resetting the peak detector to the current voltage at point A. When C3 has charged the IC3c switch will open again, allowing the peak detector to function.

IC4 is wired as a differential amplifier with a gain of 2, to subtract the voltage at point C from point B. Since these voltages are the log of the light levels, the output on pin 6 will represent the contrast ratio of these light values.

IC5 is a standard LED bargraph driver, the LM3914. The input voltage on pin 5 is converted linearly to illuminate one LED on a scale of 10. Full scale deflection (LED 10) is set internally at 1V2; the zero scale deflection is set by PR2 anywhere between 0V and 1V2 during the calibration process. C6, a 10 uF tantalum, is required for IC5 to ensure stability from oscillation.

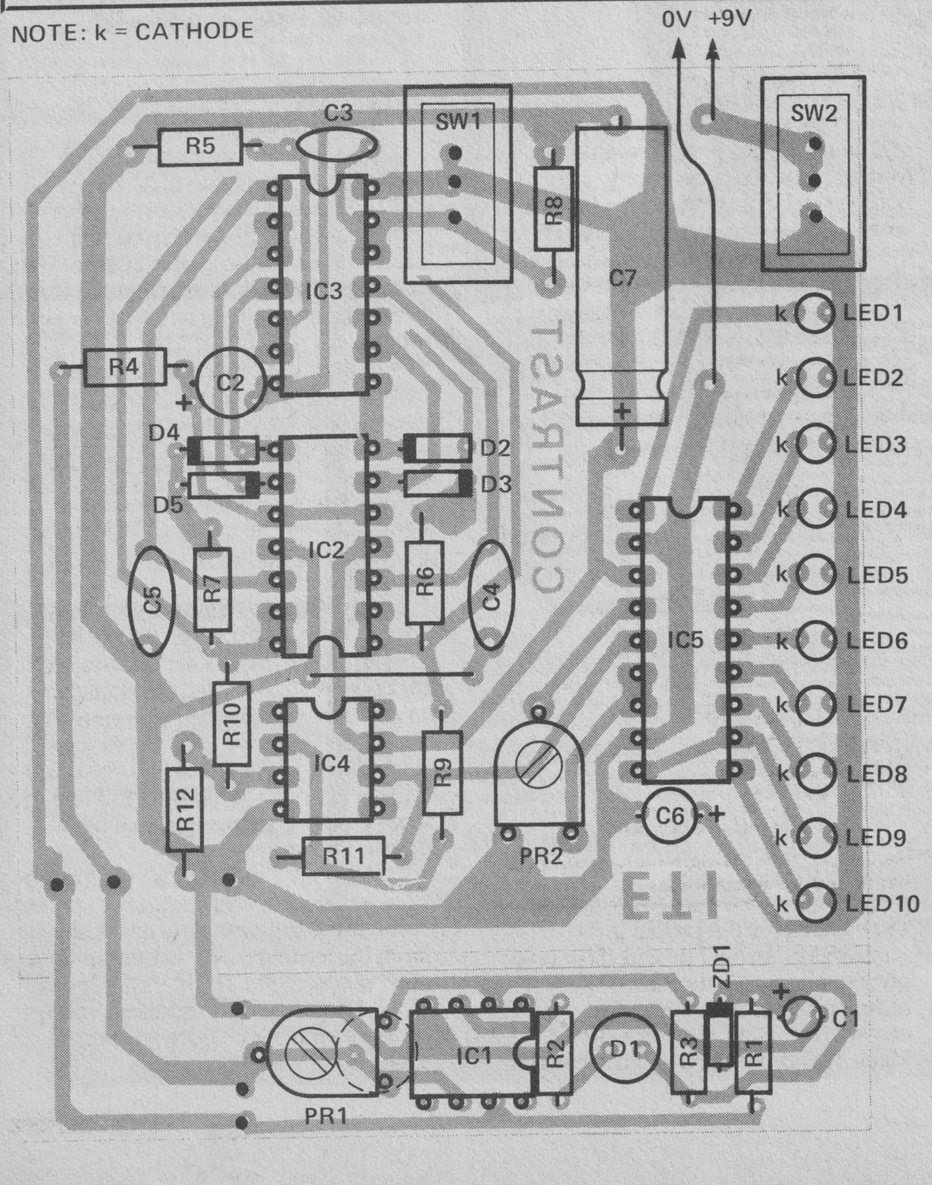


Fig. 4 (Left) Component overlay for the meter (showing the board uncut).

PARTS LIST

Resistors (all ¼ W, 5%)

R1, 3, 8	10k
R2, 11, 12	100k
R4	2k2
R5	1M0
R6, 7, 9, 10	47R

Presets

PR1	100k subminiature horizontal preset
PR2	1k0 miniature horizontal preset

Capacitors

C1	10u 35 V tantalum
C2	22u 25 V tantalum
C3	220u 16 V electrolytic
C4, 6	82n polycarbonate
C5	68 n ceramic

Semiconductors

IC 1,4	CA3140
IC2	TL084
IC3	4066B
IC5	LM3914
D1	BPX65
D2, 3, 4, 5	1N4148
LED1-10	3 mm red LED

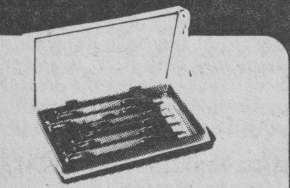
Miscellaneous

SW1, 2 miniature slide switches
Case (see Buylines); PCB (see Buylines); B1 PP3 9 V battery (preferably alkaline type).

BUYLINES

The photodiode specified in the Parts List is the one used in our prototype, but any general purpose type should do. The case we used is a Pactec type HP, size 146 x 91 x 28 mm. The PCB is available from us using the order form on page 44 — price is £2.12.

BI-PAK BARGAINS



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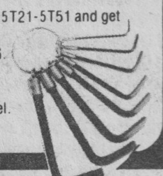

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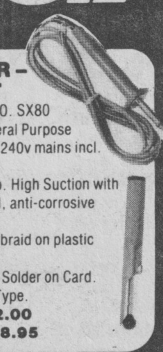

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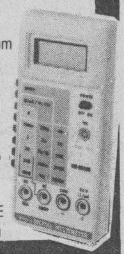

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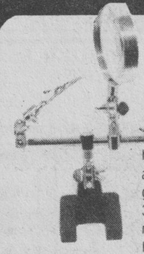

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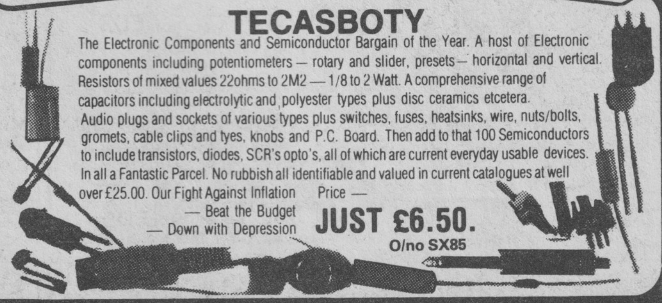

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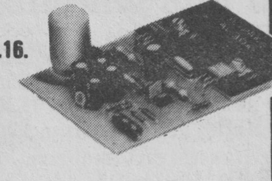

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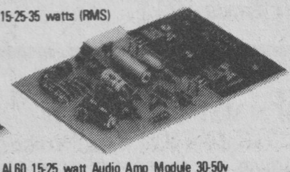

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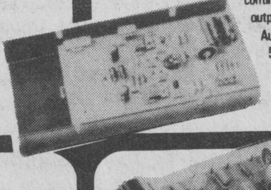

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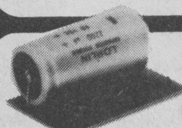

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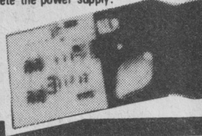

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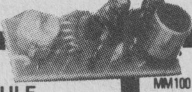

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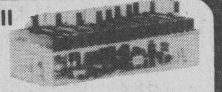

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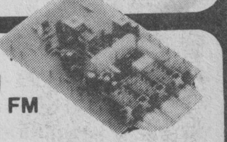

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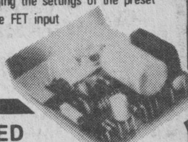

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DESIGNER'S NOTEBOOK

Five into one does go. This month Don Keighley explains all about sampling and time-division multiplex systems, and looks closely at the advantages of pulse-width modulated telecommunications networks.

Sampling is a process we can undertake if we want to combine many different signals on to a single transmission line. The transmission line can be of any type such as wire, radio, or optical. Combining several signals into one is called 'multiplexing' and can save the expense of having many separate lines. Sampling is used in a specific type of multiplexing called time-division multiplexing (TDM) which I'll explain later. The other form of multiplexing — frequency-division multiplexing (FDM) — is the basis of all standard radio transmissions. Each signal to be transmitted is mixed with a carrier wave (or radio frequency) on to a set frequency within the radio spectrum. Thus many signals can be transmitted and received by radio link — one on each defined frequency of the radio spectrum.

Figure 1 shows an illustration of sampling. In the figure, a sinusoidal signal (known as the message signal) has a series of values taken at regular intervals. These sample values can be used to represent the message signal. For instance, we can pass the actual DC values of the samples, ie their voltages, along the line. At the other end of the line the sample values, or pulses as they are usually called, are converted back into the message signal, simply by passing them through a lowpass filter. The filter removes the high frequency pulses and thus re-creates the envelope of the original message signal — as shown by the sinewave of Fig. 2.

One of the most important questions arising is — How often do we need to sample the message signal? It is obvious that if the signal is sampled too few times we won't be able to reconvert the pulses into the message signal at the receiving end of the transmission line.

The minimum number of samples is given by the sampling theorem, which states that a message signal of bandwidth B Hz can be represented by a set of sample values taken at a frequency of 2B Hz. For example, an audio system has a frequency response of 20 Hz to 20 kHz. Its bandwidth is thus 20,000 − 20 = 19,980 Hz. The audio signal of the system can thus be represented if samples are taken at 2 x 19,980 Hz = 39,960 Hz.

But the *minimum* number of representative samples (2B Hz) isn't the *easiest* number of samples to convert back into the message signal. It's usual to take a greater number of samples because doing so makes the reconversion easier. To see why this is so we've got to take a look at the spectra of the transmitted samples and see how they differ when different sample frequencies are used. Figure 3 shows the possible spectrum of a message signal such as an audio signal. It's the sort of result you would see on the screen of a spectrum analyser. Frequency f_m is the maximum frequency contained in the signal. The lowest frequency contained is 0 Hz (the signal extends down to DC); so the bandwidth of the message signal is $f_m - 0 = f_m$ Hz.

When the message signal is sampled at a frequency f_s the overall spectrum looks something like that shown in Fig. 4 and consists of components at harmonics of the sampling frequency, with upper and lower sidebands around them, as well as the original spectrum of the message signal. In Fig. 4 you can see the sampling frequency, f_s, is more than twice f_m — hence there is a gap between the highest frequency of the higher sideband of a

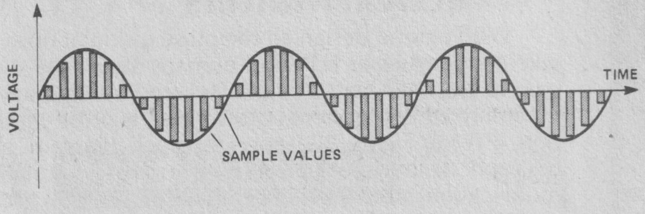

Fig. 1 A message signal can be represented by a series of sample values of the signal.

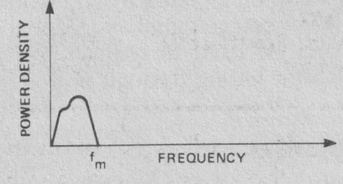

Fig. 3 Power density spectrum of typical audio signal. The higher frequency component in the signal is f_m. The signal extends down to 0 Hz, so the bandwidth of the signal is f_m Hz.

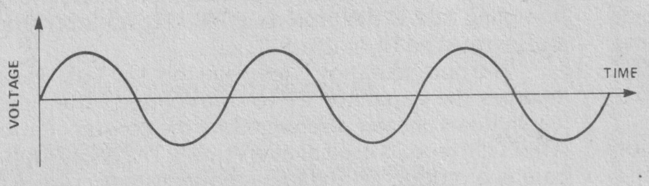

Fig. 2 If the series of sample values is passed through a lowpass filter the original message signal is recreated.

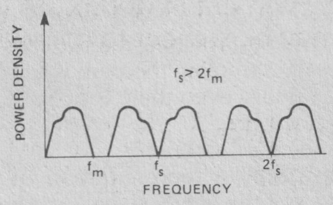

Fig. 4 Power density spectrum of an audio signal, sampled at a frequency of f_s. In this example, f_s is greater than $2f_m$.

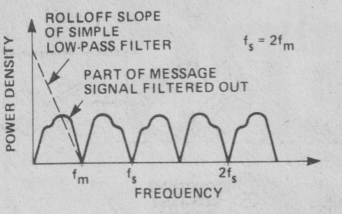

Fig. 5 Sampling frequency f_s equals $2f_m$. A simple lowpass filter may filter out some of the wanted message signal.

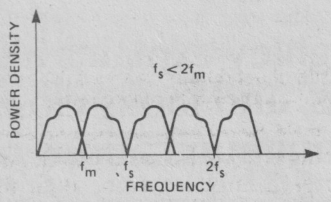

Fig. 6 Sampling frequency less than $2f_m$. A lowpass filter cannot be used to recreate the original message signal.

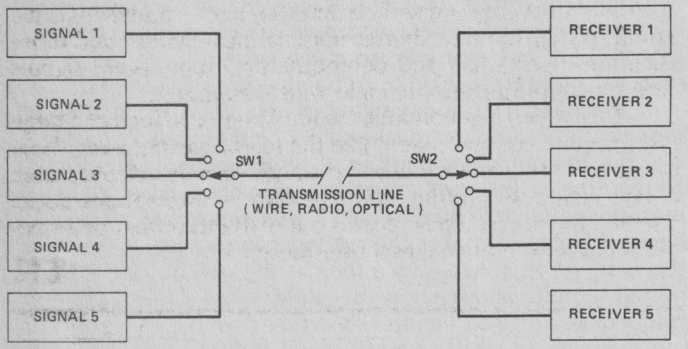

Fig. 7 A simple time-division multiplex (TDM) system.

component and the lowest frequency in the lower sideband of the next component. This gap between bands means that a simple lowpass filter can be used at the receiver to pass only the message signal and not the higher components: so the message signal is recreated.

With a sampling frequency of only $2f_m$ (Fig. 5) the highest frequency of one band and the lowest frequency of the next occur at the same point. A simple lowpass filter would filter out some of the message signal, as shown in the figure. A more complex lowpass filter (with a steeper roll-off slope) could be used to correctly recreate the message signal.

In Fig. 6, f_s is less than $2f_m$ and, as you would expect, the spectrum shows how message signal and sidebands overlap. A lowpass filter *cannot* be used to recover the whole of the message signal without letting through part of the next sideband.

TDM Tricks

A simple TDM system is shown in Fig. 7, in block diagram form. Each signal to be transmitted is connected to an input of switch SW1. This switch, although shown in the diagram as a mechanical-type switch, will be of electronic construction in a real TDM system, so that a high switching speed can be obtained. The output signal from the switch is transmitted along the transmission line to switch SW2, which connects each receiver, in turn, to the line. Providing the switches are operating fast enough so that the sampling theorem is fulfilled ($f_s \geq 2f_m$) for *all* the message signals, everything is fine and we have five signals passing down one line.

The whole process of sampling and TDM is a form of modulation because only a representation of the message signal is transmitted, not the actual signal. And because pulsed samples of the message signal are transmitted, we call the process pulse modulation.

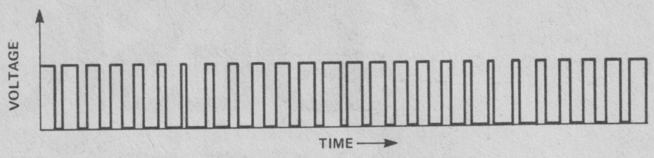

Fig. 8 Pulse-width modulation. The width of each pulse varies in accordance with the amplitude of the message signal.

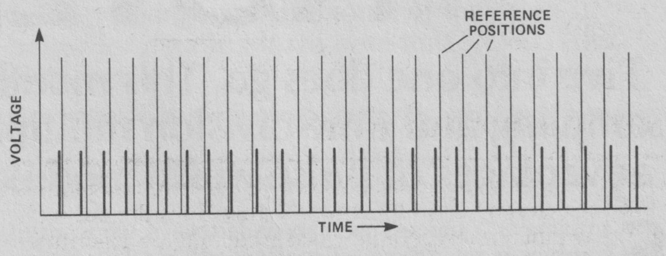

Fig. 9 Pulse-position modulation. Each pulse's position, with respect to a reference point, varies in accordance with the message signal amplitude.

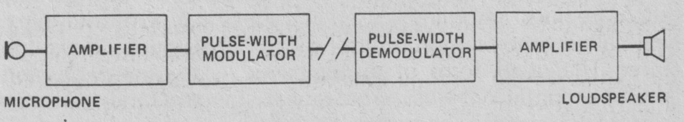

Fig. 10 A pulse-width modulation microphone/loudspeaker system.

There are various forms of pulse modulation which can be used in a TDM system, all relying on the fact that the original sample values control some property of corresponding pulses. The one just described uses the DC value (ie amplitude) of the pulses and is therefore known as pulse-amplitude modulation. Other forms of pulse modulation are: pulse-width modulation (where the width of the pulses is varied according to the sampled value) and pulse-position modulation (the position of the pulse, relative to a reference position, is proportional to the sample value). Figures 8 and 9 show examples of these pulse modulation systems and the sampling frequencies of both must follow the sampling theorem — the sampling frequency must be at least twice that of the message signal bandwidth. There is a final pulsed system, in which each sampled value is converted into a train of binary digits. This is, strictly speaking, a digital system and doesn't concern us here; however the system must still follow the sampling theorem.

Practical Matters

With careful design all the pulse modulation systems can give good results in TDM but perhaps the best — because it's easy to use, has a high immunity to interference and yet needs a minimum of component hardware — is pulse-width modulation (PWM). Figure 10 shows a block diagram of a PWM microphone/loudspeaker set-up — such as you might have in a multi-station intercom system or similar.

We can investigate the modulation and demodulation blocks in more detail, as in Fig. 11 and 12. Figure 11 shows a simplified pulse-width modulator. It consists of an oscillator to provide sampling pulses at a rate of over $2f_m$, so that the sampling theorem is fulfilled. In a good quality audio modulator, the sampling rate is therefore over 40 kHz and the time between pulses must be $1/f_s = 25$ uS.

The pulse duration is less than this, say 1 uS, and each pulse charges the capacitor C1 to full voltage. After charging, the capacitor is linearly discharged via the constant current source. The cycle repeats itself at every pulse. The capacitor's discharge rate is a product of the capacitor/constant current time constant, which should be about 2 uS. Comparator IC1 compares the ramp discharge with the incoming audio signal — when the non-inverting input voltage is above that of the inverting input

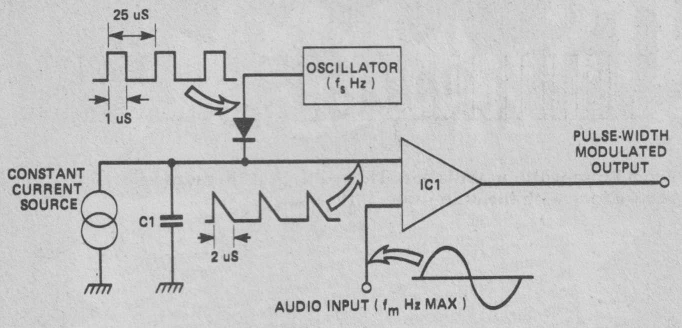

Fig. 11 A pulse-width modulator in detail.

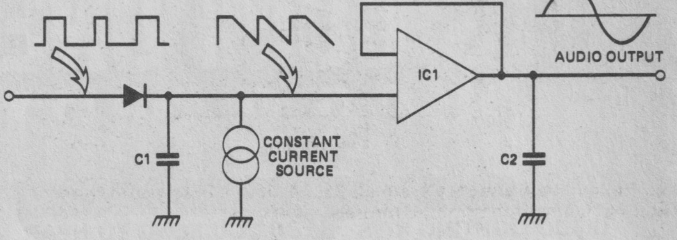

Fig. 12 A pulse-width demodulator can be built using the same basic components used in a pulse-width modulator.

the comparator output is high; when the non-inverting input is below the inverting input the output is low. Thus the output is high the instant of every sampling pulse, but falls low again after a time which is linearly related to the amplitude of the audio signal. In other words, the width of the pulse is modulated by the audio signal.

A pulse-width demodulator is shown in Fig. 12. A capacitor with a parallel constant current source is again used and the incoming width-modulated pulses cause a charge/discharge cycle similar to that in the modulator. The average DC level of charge across the capacitor is dependent on the width of the pulses — the wider the pulse, the higher the DC level. Buffer IC1 prevents loading of the voltage across the capacitor and the output is lowpass filtered by capacitor C2 to remove the sharp spikes of the sampling pulses, thus re-creating the original audio message signal.

The advantages of such a system aren't always immediately obvious, but you must remember that the audio signal is being represented by a pulse of nominal width 2 uS in a cycling time of 25 uS. This means that 12 different, high-quality audio signals can be time-division multiplexed down that transmission line simultaneously and without interference — and this is just a simple system. With a shorter nominal pulse width and more accurate modulators and demodulators, many more signals can be multiplexed on to a single transmission line.

It's all down to economics really. When you look at a large telecommunications system like the telephone network, there are literally thousands upon thousands of miles of expensive copper cable. By putting 100 telephone conversations down one line the overall cable cost is only 1/100th of that of a non-multiplexed system. Makes sense, doesn't it!

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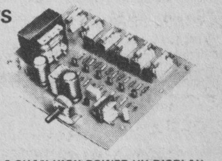

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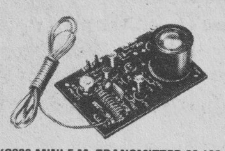

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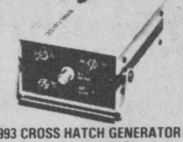

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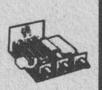

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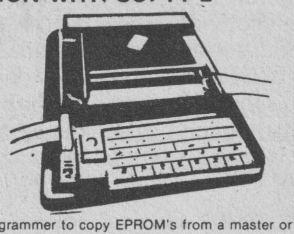

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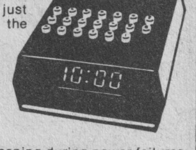

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0.047	.07	0.33	.12	2.2	.31
0.068	.07	0.47	.15		
400V d.c.					
0.1	.15	0.47	.24	1.0	.35
0.22	.17				

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10pF, 15pF, 22pF, 47pF, 68pF	.07
82pF, 100pF, 220pF, 330pF, 470pF	.07
1,000pF, 2,300pF, 3,300pF	.08
4,700pF, 6,800pF	.12

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2.2/63 r	.05	22/16 r	.05
4.7/63 r	.06	33/16 r	.05
10/63 r	.07	47/16 r	.06
47/63 r	.12	100/16 r	.08
		220/16 r	.11
22/25 a	.08	470/16 r	.14
47/25 a	.10	1000/16 r	.20
100/25 a	.14		
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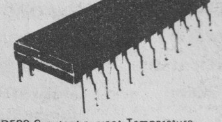

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Rectangular	5x2.5mm	17p	20p	20p
Square	5x5mm	17p	20p	20p
Triangular	5mm	17p	20p	–
Arrowhead	2.5x5mm	17p	20p	–

[Flashing Leds]
5mm diameter Red.......39p Flashing/Continuous.....42p

[Tri Colour Leds]
5mm round.......30p 5mm Rectangular........32p

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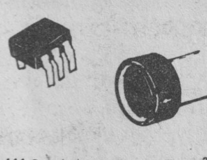

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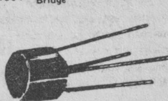
3A/400V Bridge	.58



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400mW: 3.3V, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10, 12, 15, 18, 24, 27V .08
1.3W: 7.5V, 8.2, 9.1, 10, 12, 15, 18, 24, 27V .15

VOLTAGE REGULATORS

78L 100mA Positive 5, 12, 15V	.26
79L 100mA Negative 5, 12, 15V	.60
78 Series 1A positive 5, 12, 15V	.52
79 Series 1A negative -5V	.75
LM317T 1.2v-37v adjustable 1.5a	1.80

BOXES

Boxes with lids, ABS, Black	
B1 75 x 56 x 35mm	.65
B2 95 x 71 x 35mm	.85
B3 1,15 x 95 x 37mm	.95
B4 150 x 100 x 60mm	1.10
Potting Boxes (Grey)	
PB1 28 x 48 x 23mm	.18
PB2 38 x 51 x 25mm	.24
PB3 60 x 80 x 42mm	.34
Clock Box	2.20
Digital Enclosure	1.75
Sink Box - Black Aluminium	4.50
Hand-held control box with battery compartment. Ideal for remote control transmitter (MK8). Colour: Black	3.60
Mains supply case. For housing power supplies for calculators, radios, etc. Plugs into 13A mains socket. Colour Black	
MP1 51x77x58mm	1.20
MP2 56.5x92x62.5	1.50

REMOTE CONTROL COMPONENTS

If you can design your own system, we stock a wide range of remote control components at very competitive prices.

	£
LD271 IR Emitting Diode	.36
SFH205 Photodiode Detector	.90
SL480 IC Pulse Amp.	1.70
SL490 32 Command Encoder/transmitter	2.40
ML922 10-channel receiver + 3 analogue outputs	4.20
ML924 Programmable RC Receiver	1.95
ML925 A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights etc.	£2.10
ML926 16-channel receiver, 4 momentary binary outputs.	1.40
ML927 16-channel receiver, 4 momentary binary outputs.	1.40
ML928 16-channel receiver, 4 latched binary outputs.	1.40
ML929 16-channel receiver, 4 latched binary outputs.	1.40
Clip-on plastic reflector for IR LEDs, increases range.	.20

We have compiled a booklet on remote control, containing circuits, hints, data sheets and details of our remote control kits and components. So don't control yourself – Send us 30p and a stamped addressed envelope for your copy TODAY!

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BC108 npn	.08	BC337 npn	.13
BC109 npn	.15	BFY50 npn	.20
BC182 npn	.08	TIP31A npn	.40
BC182L npn	.08	TIP32A pnp	.40
BC212 pnp	.09	2N3055	.45
BC212L pnp	.09	2N3442 115W 140V	.90
BC327 pnp	.12	2N3819 N ch fet	.20

VMOS Power Fets

VN10KM 0.5A/60V	.52
VN66AF 2A/60V	.88

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¼W 5% E12 Series 10 ohm-10 Mohm

Per pack of 10	.10
10 packs (10 values)	.80

Presets

100 ohm h	.08	47K h/v	.08
470 ohm h	.08	100 h	.08
1 Kohm h	.08	470K h/v	.08
4.7Kohm h	.08	1 Mohm v	.08
10 Kohm h/v	.08		
22 Kohm v	.08		

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Texas Scambe etc.

8-pin	.08	22-pin	.19
14-pin	.12	24-pin	20
16-pin	.14	28-pin	.25
18-pin	.17	40-pin	36
16-pin c.i.l. Plug			.50
Soldercon Pins – per 100			.80

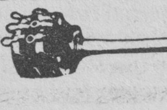
TRIACS

400V Plastic Case (texas)	3A TIC206D	49p
	8A TIC226D	58p
	12A TIC236D	85p
	16A TIC246D	96p
	25A TIC263D	190p
6A with trigger Q4006LT		85p
8A isolated tab TXAL228B		65p
Diac		18p
Opto isolated triac MOC3020 0.1A/400V		110p

SCRS

2N5060 30V/.6A	.25
2N5064 200V/.6A	.25
C106D 3A/400V	.28
TIC106D 5A/400V	.40
Trigger	
Diac	.18
2N6027 PUT	.40

POTENTIOMETERS



(Rotary)

Linear – no switch	
1K, 4.7K, 10K, 22K, 47K 100K, 470K, 1M, 2.2M	.30
Log. No Switch – 10K	.30
With DPST Switch	
Lin: 2.5K, 5K, 10K, 100K, 250K	.50
Log: 5K, 10K, 50K, 100K, 500K	.50
Dual Gang	
Lin: 1K, 10K, 100K	.60
Log: 5K, 10K	.60

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Based on the ZN 1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1 KW. **£4.50**

74 LS TTL

LS00	.12	LS14	.48	LS42	.40	LS93	.37
LS01	.12	LS15	.15	LS47	.42	LS95	.48
LS02	.13	LS20	.14	LS51	.15	LS107	.24
LS03	.13	LS21	.15	LS54	.15	LS109	.24
LS04	.14	LS22	.15	LS55	.15	LS112	.24
LS05	.15	LS26	.18	LS73	.20	LS113	.24
LS08	.15	LS27	.15	LS74	.18	LS114	.24
LS09	.15	LS30	.14	LS75	.27	LS123	.51
LS10	.14	LS32	.15	LS76	.21	LS126	.29
LS11	.15	LS37	.17	LS85	.64	LS132	.44
LS12	.15	LS38	.16	LS86	.18	LS160	.40
LS13	.27	LS40	.14	LS90	.32	LS161	.40

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4002	.14	4028	.50	4511	.85
4007	.14	4040	.68	4514	1.80
4011	.15	4049	.30		
4012	.17	4050	.30		
4013	.35	4060	.90		
4015	.70	4069	.18		
4016	.30	4070	.24		
4017	.65	4071	.22		
4019	.38	4077	.24		
4023	.22	4081	.22		
4025	.18	4043	.58		

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SOUND EFFECTS 1: BOMB DROP

One of the attractions of the more sophisticated video games seen in 'fun' arcades these days is the realistic array of sound effects that go with the action — gunshots, bomb whistles and explosions, etc. Make some yourself with just one IC. Design by Phil Wait.

Those 'cannon shots' and explosions that go with the popular 'Space Invaders' video games and its variants add a measure of interest, feedback and stimulation to the action in which you participate on screen. Those sounds are electronically synthesised — that is, they consist of a complex mixture of waveforms that make up the required sound.

A 'bomb drop and explosion' is a remarkably complex sound when analysed carefuly. Looking at it simply, there is a descending tone followed by a burst of noise that dies away in intensity. The descending tone starts at quite a high pitch and is not a 'pure' tone (ie a sine wave). The explosion is a burst of noise that commences suddenly and dies away slowly in a recognisable way (usually exponentially). While it is possible to electronically produce very nearly an exact replica of a bomb drop and explosion, some compromises are acceptable to reduce the complexity and cost of the task and yet produce a recognisable replica of the sound.

To produce such sound using conventional components — transistors, diodes, op-amps, resistors and capacitors — would require a whole legion of components. Fortunately, the IC maufacturers can come to our rescue here and much of the circuitry can be incorporated into a complex integrated circuit requiring the addition of a minimum of external components and the appropriate interconnections to synthesise the required sound. Generating a wide variety of sounds fortunately requires only a limited number of functional blocks, such as: a noise generator, voltage controlled oscillators, multivibrators, envelope generators (a sort of modulator), mixers and amplifiers. Tim Orr discusses such circuitry elsewhere in this issue.

Texas Instruments, the giant US-based component and equipment manufacturer, have designed a series of complex function ICs for various applications and among them is the SN76488 Complex Sound Generator. This chip contains both linear and digital circuitry and is intended for use in applications requiring audio feed-back to the user — video games, pinball, alarms, toys, etc, or industrial indicators, feedback controls and the like. Power consumption is quite low, allowing battery operation, and only a single supply rail is required.

The SN76488 is contained in a 28-pin package and can be purchased for less than £5. It is quite a versatile chip, but we have chosen to describe how to obtain only two sound effects, these being a bomb drop and explosion, and a steam train and whistle. The former is described here; the latter appears on page 118.

Construction

Both the projects described use the one PCB design. Only the required components are assembled into the board according to each overlay diagram to obtain the required sound generator. Naturally enough, the polarity of the IC should be noted as well as the polarity of electrolytic and tantalum capacitors used. Commence construction by assembling the passive components, followed by the IC. This is not a CMOS device and no special care is required, apart from being careful not to bend any pins under the device when inserting it. If you wish, a socket may be used for the IC. This way, you can assemble both projects and purchase only one IC, swapping between the boards as you need to use them!

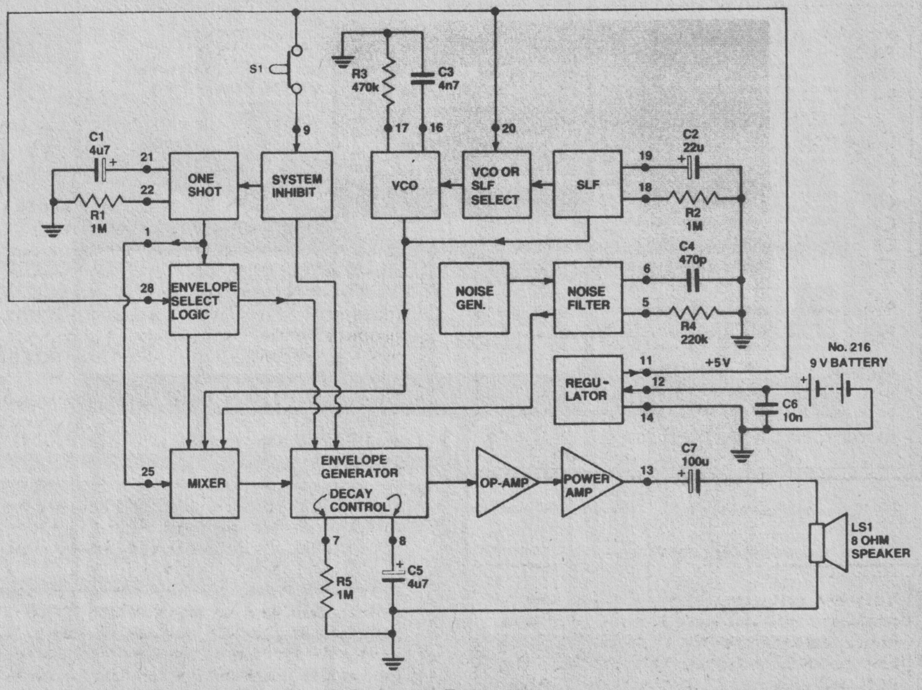


Fig. 1 Circuit diagram of the Bomb Drop and Explosion sound effects board.

Wiring to the switches, the speaker and the supply should be attached last.

The unit may be mounted in any convenient-sized box and the speaker mounted on the front. Alternatively, it may be wired into an existing piece of equipment. We'll have to leave these arrangements up to you.

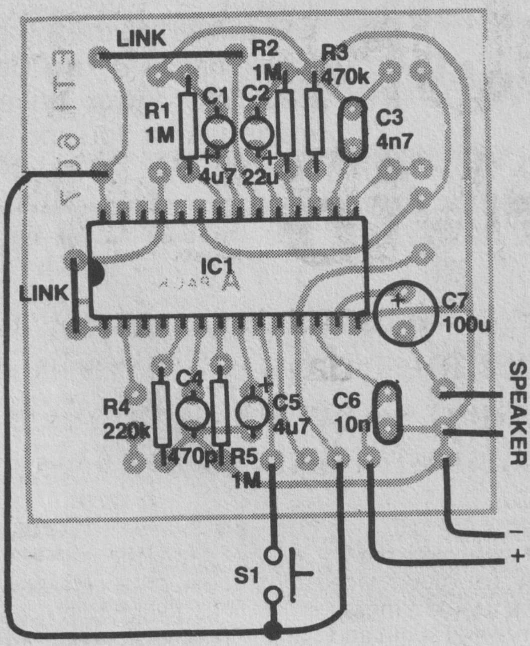


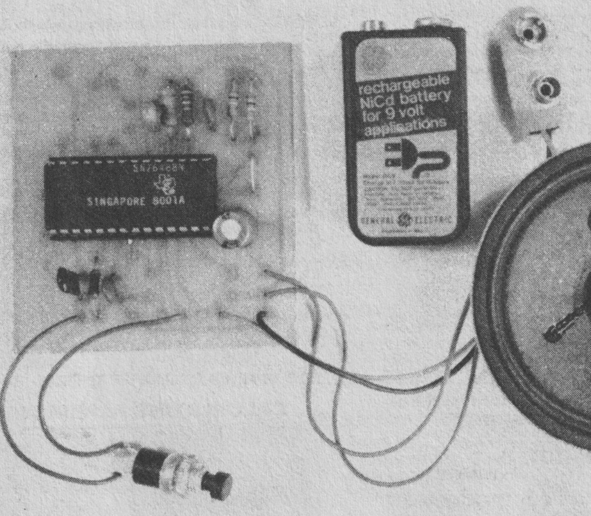
Fig. 2 Component overlay for the Bomb Drop board.

Projectile Project

This produces a 'bomb drop and explosion' sound at the press of a button. Alternatively, the push-button PB1 could be replaced by a pair of relay contacts operated by a piece of equipment or a transistor (emitter to pin 9, collector to other side of PB1) that is turned on by a logic high applied to its base via a resistor.

This project is one of the most complex, using almost every functional block within the SN76488. Varying R3 and C3 a little will vary the pitch range of the 'bomb drop' (desending whistle), while varying R4 or C4 a little will alter the characteristics of the explosion. Note that it is generally easier to 'fine tune' things by varying the resistor values. The duration of the event can be varied by changing the value of either C1 or R1 and the decay of the explosion can be changed by varying R5 (varying C5 produces quite gross changes in the decay period).

Watch that you insert the link on the PCB in this one, located at the 'notch' end of the IC.



PARTS LIST

Resistors (all ¼ W, 5%)

R1,2,5	1M0
R3	470k
R4	20k

Capacitors

C1,5	4u7 16 V PCB electrolytic
C2	22u 16 V tantalum
C3	4n7 ceramic
C4	470p ceramic
C6	10n ceramic
C7	100u 16 V PCB electrolytic

Semiconductors

IC1	SN76488 (see Buylines)

Miscellaneous

PB1	SPST push-button switch

PCB (see Buylines); 50 mm diameter 8 ohm speaker; PP3 battery and clip.

BUYLINES

Very few components and very few supply problems with this one. The SN76488 is an improved version of the Texas SN76477 and can be obtained from Technomatic. The PCB will cost you £1.80 from our PCB Service; see page 44 for details.

HOW IT WORKS

This unit employs most of the function blocks in the SN76488. The SLF provides a linearly increasing voltage waveform, or ramp, to the VCO, taking several seconds for the ramp voltage to rise from zero to maximum value. The causes the VCO to produce a tone which 'glides' down in pitch, making the 'bomb drop' effect. The explosion is generated by the Noise Generator/Filter and the Envelope Generator. It starts with a burst of noise, which dies away in intensity exponentially in a few seconds.

The whole sequence is triggered by operating the pushbutton, PB1. This applies a high (+5 V) to the input of the System Inhibit block, pin 9. This in turn triggers the One Shot and the Envelope Generator. At the commencement of the One Shot timing period, the One Shot triggers the SLF HI/LO Sync, starting the SLF, and the VCO does its things. At the end of the One Shot timing period the Envelope Select Logic becomes operative, the SLF is disabled and the Envelope Generator commences to do *its* thing. The Mixer selects the VCO output at the start of the One Shot timing period and the Noise Generator/Filter output at the end of the One Shot timing period. Thus the two sounds are switched through to the audio output stage in sequence, the Envelope Generator modifying the noise so that it dies away, the time it takes to do so being controlled by the time constant of R5, C5.

The starting pitch of the VCO is determined by R3 and C3, the rate of rise of the voltage ramp produced by the SLF is determined by C2 and R2, while the One Shot timing period is determined by the time constant of C1 and R1. The frequency characteristics of the broad-band noise produced by the Noise Generator are modified by R4 and C4 connected to the noise filter control pins (5 and 6).

Audio output is coupled to the loudspeaker via C7, a 100uF electrolytic capacitor.

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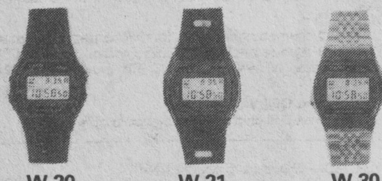

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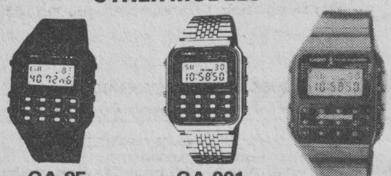

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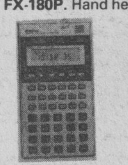

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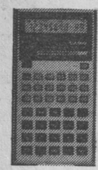

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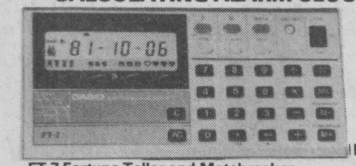

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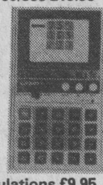

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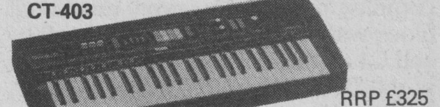

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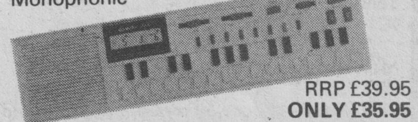

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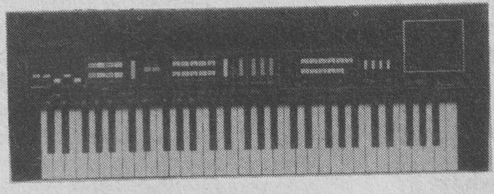

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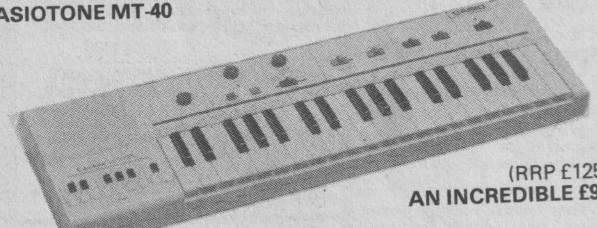

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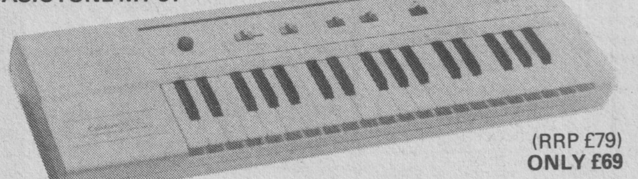

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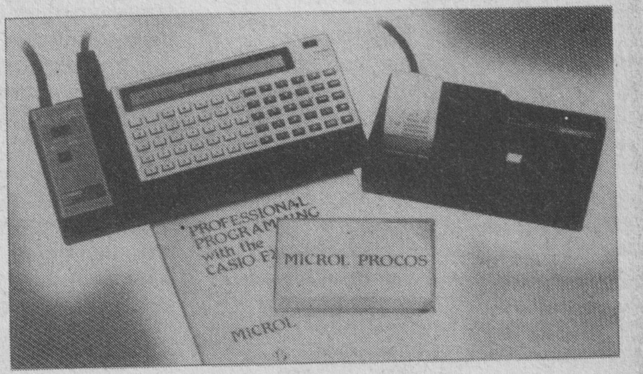

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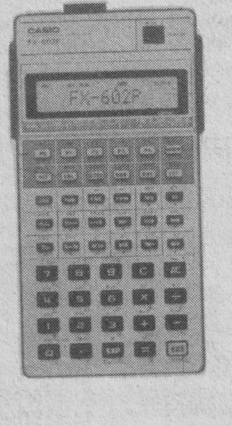

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TEMPUS

READ/WRITE

Dear Mr. Ron Harris Sir,

We seem to have been hearing quite a bit about System A recently; technically it looks a rather nice amplifier. However, it's difficult to tell how good commercially-produced units are with only limited information available about them. So what about the other end of the problem — what does System A sound like, compared with other amplifiers? Unfortunately, I can't see any of the hi-fi mags doing a review of it, so — how about you doing one (totally unbiased, of course) please, pretty please? Come on, put your reputation on the line!

Yours grovellingly,
M.R. Barrett,
Hove.

Certainly not. Someone might chop it off!

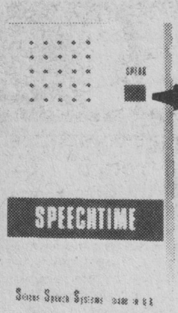
System A has a comparable sound to any of the more highly regarded commercial units. Listening tests we have conducted over the months since the creature's completion, have shown it (the power amps) to have a more detailed and open midrange/top than ANY we have compared it to. The top commercial boxes — Threshold, Monogram, Carver, etc can exhibit a better bass control than the System A however, but as to whether or not that is important for your particular application (ie loudspeaker), I could not say (because you haven't told me what speakers you've got, have you?).

Anyone contemplating building a System A is welcome to write to us for advice on speaker matching.

Dear Sir,

I read with interest the articles in the July and August editions of ETI describing the construction of the System A Audio Amplifier, as I have been on the lookout for a high-quality class A amplifier design for some time. My particular interest in class A stems from the fact that I own a pair of Lowther loudspeakers — these units are almost ridiculously sensitive, requiring only some 10 W or so of input to produce the equivalent sound output of a conventional 100 W system. Given this sensitivity, most high quality class AB amps are only ticking over when driving a pair of Lowthers, and hence are working at the highest distortion end of their operating range. Hence the interest in class A, where no penalty is paid for operating the amplifier at low levels of power output. However, before going ahead and building the System A, I would like the answers to a couple of questions. Firstly, the July article heralds System A as "quite simply the best, designed to out-perform even commercial equipment." There is, however, no objective assessment or comparison to back up this claim, and before laying out the not insignificant construction cost, I would like to see the amplifier reviewed, preferably alongside its "competition" in the commercial amplifier field. Is this a possibility?

Secondly, the high power output of the System A seems more than a slight degree of overkill in the context of my



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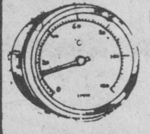

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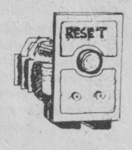

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Lowthers. Is it reasonable, therefore, to construct a lower power version of the power amp section? If so, what modifications should be made to the present design?
Yours sincerely,
T. Jeffree,
Milton Keynes

Taking the two points you raise, in order; first we feel it is inappropriate for us to review our own product against anyone else's. (Would you believe us anyway?) 'Objective' would not be an appropriate word to apply to such a test.

System A has aroused a great deal of interest and we know that a large number of sets have been completed. There is probably, however, a larger number of people still who *would* tackle the project, if only they could get to hear one first! Accordingly any owners of a System A who would be prepared to let a fellow ETI reader have a listen, can write to us and we'll run the letters herein. Secondly the high power output of the amp will *not* be wasted, even on your Lowthers, it will simply provide you with more headroom — and hence a cleaner sound with better bass output on transients.

Dear Mr Harris,
I am writing for advice on the purchase of an amplifier and speakers combination. I list my present system below:

Home-brew 10 W amp
Ferguson (?) 3-way speakers (actually 2-way, 3-cone)
Realistic 31-987 Graphic Equaliser
Hitachi D-225 Cassette Deck
Pioneer PL-300 turntable (the latest addition!)

The amplifier now ceases to be of any great use in terms of power, although quality is more than adequate (based on Bi-Pak AL30A). I have considered NAD3020, Pioneer SA410, and also the "Audiophile" amp, the MOSFET amps from JW Rimmer, and the Linsley-Hood kit from Powertran. The last three give me extra headroom, and I would like to feed them into AR18 speakers from Acoustic Research.

Basically, I would like your opinion on the Linsley Hood 75 De Luxe/AR18 combination, plus any comments on the other "possibles".

Also, the Pioneer PL300 I have just bought is certainly the best turntable I have heard at the price (£79.95), and I can't help wondering why it gets so little attention. Perhaps you can fill me in?
Thank you for your valuable time,
D. Crary,
Ilford, Essex

PS When is Felicity Kendall to return to our screens?

The AR18 is a fine unit and if you like the sound of them, go ahead and buy yourself a pair. You haven't named your cartridge so I've no idea if it matches.

Ditch the equaliser, with decent speakers and amp, you won't need it!

As to amplifiers, from the units you mention the Linsley Hood power amps are the best bet, but the preamp of that unit is getting a bit long in the tooth now, although the sound quality is still very good by any standards. Have a listen to the Crimson CK1010/1100 set-up before you decide, however, as it is in your price range and offers a high-quality alternative.

The Pioneer PL300 I have not been able to listen to at any length and must thus refrain from commenting upon!

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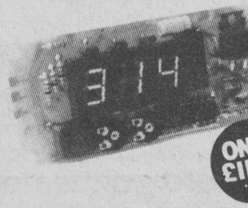

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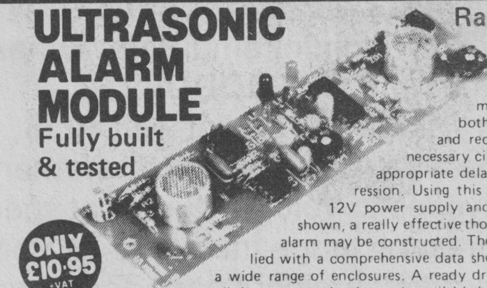

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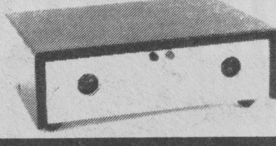

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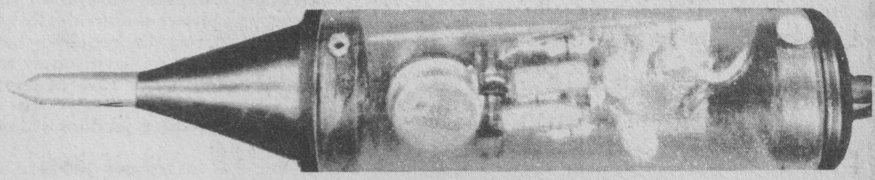


Most readers would be aware that, when taking a measurement on electronic circuitry, the input impedance of the measuring instrument must be much greater than the impedance of the circuit to which it is attached, otherwise the accurary of the measurement suffers. The input impedance of the majority of oscilloscopes is generally 1M0 with a parallel capacitance of between 20pF and 40pF. For a wide variety of applications this is perfectly adequate and will suffice for measurements of frequencies up to 5 MHz or so. The input impedance of the CRO falls with increasing frequency owing to the falling reactance of the input capacitance. For example, a capacitance of 30pF — which may be made up of direct input capacitance plus cable capacitance — has a reactance of only 500 ohms at 10 MHz. The input capacitance also affects the rise time of the input — that is, the speed at which a 'step' input will rise from the 10% amplitude value to the 90% amplitude value.

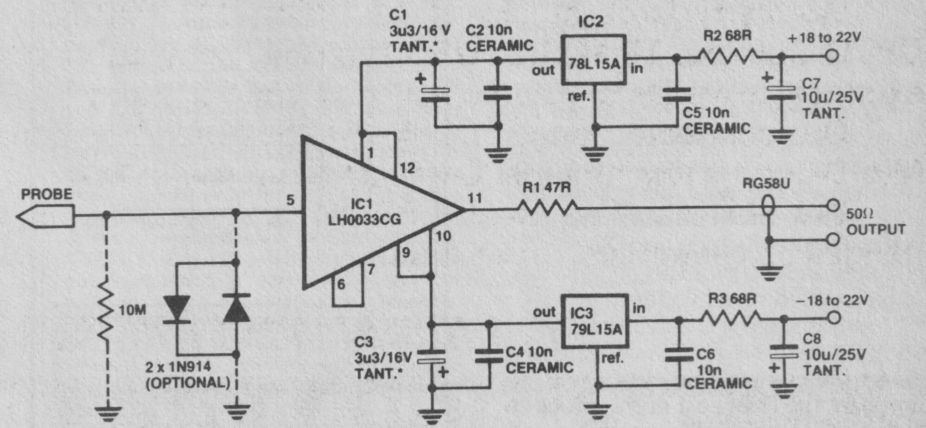
The input impedance of an oscilloscope can be effectively raised, and the capacitance decreased, by using a 'stepdown' probe. For example, a 'x10' probe will generally have an input impedance of 10M and a parallel capacitance of between 5pF and 15pF. While this improves the input impedance there are two trade-offs. Firstly, unless elaborate (and expensive) compensation is employed, the rise time is degraded, and secondly, maximum sensitivity is decreased by a factor of 10. As Murphy's law would have it, your CRO will run out of grunt just when you need it most.

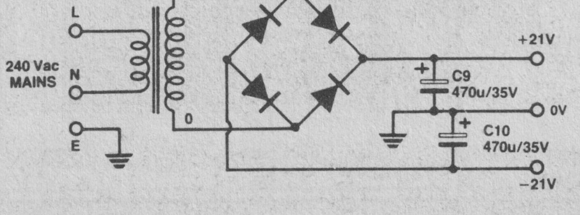
Taking the situation with digital counter/timers, we find similar problems. Those that operate beyond 30 MHz or 50 MHz generally employ a prescaler with an input impedance of 50 ohms — which is perfectly all right if you're working on low impedance circuits and/or with high signal levels. But there are those occasions when you need a high impedance input and a fast (high frequency) rise time. As with the CRO, this is where your counter/timer runs out of grunt.

It's times like these you need this project; a x 1 active instrument probe using a special buffer IC with an input impedance of typically 100,000 megohms! — that's 10^{11} ohms — a very low input capacitance of around four to five picofarads, a fast rise time (around three nanoseconds) and a bandwidth of 100 MHz. Output impedance is around 50 ohms and the device is capable of driving capacitive loads up to several thousand picofarads. Thus it is eminently suited for use with high speed, wide bandwidth oscilloscopes and digital frequency meter/timers at frequencies up to 100 MHz. Output impedance is close to 50 ohms and it is thus suited tc drive both high impedance instrument inputs and low impedance inputs (which are generally 50 ohms).

Design

It's all done inside a special IC — an LH0033CG from National Semiconductors. This is described as a 'fast buffer amplifier'. (It has a companion designated LH0063, described as a 'damn fast buffer amplifier'!). The LH0033 is a direct-coupled FET-input voltage follower/buffer (gain ≃1) designed to provide high current drive at frequencies from DC to over 100 MHz. It will provide ±10 mA into 1k0 loads (±100 mA peak) at slew rates up to 1500 V/uS, and the chip exhibits excellent phase linearity up to 20 MHz. No offset voltage adjustment is required as the unit is constructed using specially selected FETs and is laser-trimmed during construction. Input is directly to the gate of a





*AXIAL LEAD SOLID TANTALUM CAPACITOR

Fig. 1 Circuit diagram for the probe. C2 and C4 need to be ceramic

Fig. 1 Circuit diagram for the probe. C2 and C4 need to be 10n ceramic chip or 1n0 ceramic disc or plate types. C5 and C6 need only be disc or plate ceramic. See 'Bypassing' over the page.

junction FET, operated as a source follower, driving a complementary output pair of bipolar transistors.

Regulated plus and minus supplies of 15 V each provide power to the IC. Low-power three-terminal regulators are used to keep the unit compact. An external unregulated supply of between 18 and 22 V at around 50 mA is required to power the probe.

The supply pins on the IC need to be well bypassed over a wide frequency range so that the IC can maintain its characteristics, and the construction has been specially arranged to achieve this. Axial lead solid tantalum capacitors are used to bypass the IC's supply pins at the lower frequencies, while low inductance ceramic capacitors are employed as bypasses for the higher frequencies. A double-sided fibreglass PCB is used to preserve the high frequency response and the high input impedance, and the layout is arranged to permit direct connection to the probe tip and provide low input capacitance.

However, the presence of the PCB substrate will degrade the input impedance, surprisingly enough, and you can drill out the area of board immediately beneath pin 5 of the IC and solder the pin directly to the probe tip. For those who wish to go 'all the way' (as Frank Sinatra sings), the plastic insulation of the probe tip can be replaced with a similar piece of Teflon — if you can afford it and have access to a lathe.

The maximum input voltage permissible, when driving a high impedance load, is plus or minus 15 V. When driving a 50 ohm load, maximum input voltage permissible is only plus or minus 10 V (limited by maximum output current). No input protection has been included. However, if you are only working with circuits where voltages are no greater than about 1 V peak-to-peak, protection can be added by putting two diodes back-to-back in parallel with the input, along with a 10M resistor. The maximum input voltage figures include any DC voltages present, *plus* the superimposed signal voltage.

At this stage it is only fair to tell you that the LH0033CG is an expensive device (by comparison). But — compare the total cost of this probe to a similar commercially-made type and you won't catch your breath a second time!

Construction

The project is constructed on a small double-sided fibreglass PCB *with*

BYPASSING

Supply lead bypassing is important in order that the LH0033 can operate correctly over the full bandwidth from DC to 100 MHz. To ensure this, the bypassing has been specially arranged and the techniques employed are probably unfamiliar to many readers.

The output circuit signal return path for the IC is via the ground and the two supply rails. Any significant impedance in series with this path (or paths) will subtract signal from the output load. Thus, the supply rail bypassing has to present an impedance which is a *fraction* (like one-tenth or better) that of the minimum output load impedance. Here, the minimum output load is about 100 ohms (R1 + 50 ohms instrument input impedance) and the supply bypassing impedance should ideally be less than 10 ohms across the frequency range.

The bypassing on each supply rail to the IC leads here takes advantage of the characteristics of three separate components to cover three sections of the frequency range.

From DC to around 100 kHz, each three-terminal regulator (IC2, IC3) has an output impedance well below one ohm, rising to four or five ohms at 1 MHz, as shown in Fig. 1. The two tantalum capacitors, C1 and C3, then take over.

Solid tantalum capacitors have a characteristic impedance that falls with frequency according to its value, which then 'flattens out' in the region around 500 kHz — 1 MHz, rising to a few ohms around 10 MHz, as can be seen in Fig. 2. Thus, C1 and C3 serve as effective bypasses across the range from around 100 kHz to around 10 MHz. Axial lead tantalum capacitors were chosen as their construction exhibits the slowest impedance rise following the minimum impedance value.

To provide bypassing over the decade from 10 MHz to 100 MHz, capacitors C2 and C4 have been specially chosen and positioned on the PCB. For the prototype, 'chip' ceramic capacitors were used. These tiny, 'naked' chips of ceramic with a capacitor embedded in them are probably the most effective bypass capacitors made. The leads and physical construction of all capacitors form an inductance which is effectively in series with the capacitance of the component. The combined effect forms a series resonant circuit, the frequency of which (that is, the self-resonant frequency of the component) is mainly dependent on the length of the connecting leads, the particular construction of the capacitor and the way in which it is mounted. Ceramic chip capacitors, being a tiny block with connecting pads or surfaces on each end, have extremely low values of series inductance and thus very high self-resonant frequencies — see Fig. 4. Now, any value of chip capacitor between 1n0 and 10n can be used for C2 and C4. The self-resonant frequency of a 1n0 chip capacitor is somewhat above 100 MHz (as per Fig. 4), but that of a 10n chip is between 40 MHz and 50 MHz. Now, this isn't a problem, for the chip's impedance falls with frequency as usual until near the self-resonant frequency where it falls rapidly, reaching a minimum at the self-resonant frequency. Above that frequency its impedance rises again, but is still low enough for effective bypassing.

Ordinary ceramic disc and plate capacitors behave in much the same way. The self-resonant frequency of a typical 5 mm diameter disc or 5 mm square plate capacitor depends on the lead length, as shown in Fig. 5. Thus, you could use 470pF or 1000pF (1n0) capacitors of this type for C2 and C4, provided you installed them on the underside of the board with *absolute minimum lead length.*

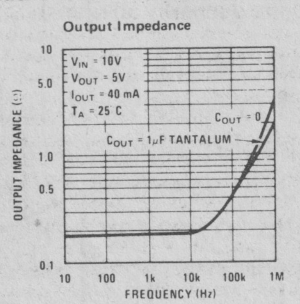


Fig. 1.

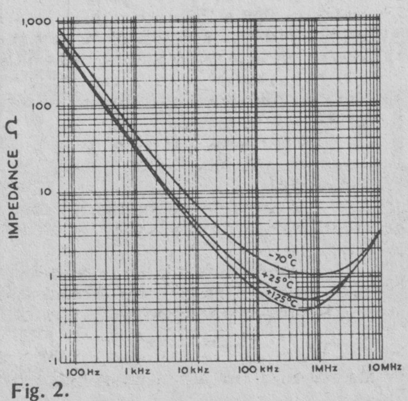


Fig. 2.

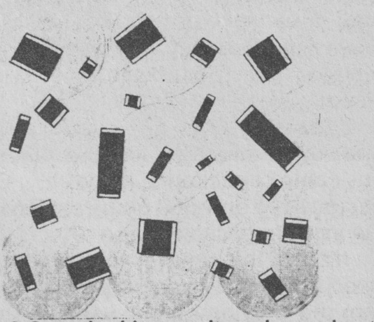


Fig. 3 Ceramic chip capacitors shown about actual size.

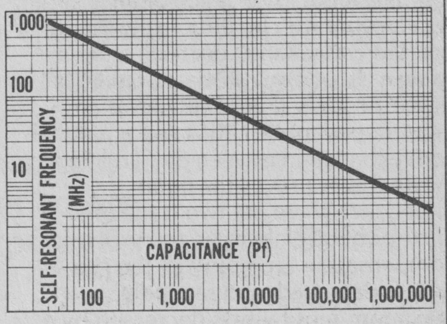


Fig. 4.

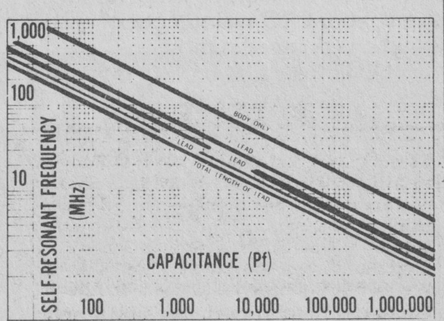


Fig. 5.

components mounted on both sides of the board. Commence by soldering in place the components that go on the top side of the board, leaving IC1 until last. Note that the positive leads of both C3 and C8 are soldered to the groundplane areas on both the top and the bottom sides of the board. Take care with the orientation of the tantalum capacitor, as well as IC2 and IC3. Having done that, solder C2, C4, C5 and C6 to the bottom side of the board. Now you can install IC1. You will have to juggle the legs a little. Push the can as far down on the board as you're able; its base should sit no more than 3 mm from the board.

Now that you have everything in place, *check it all.* It seems pretty simple, but Murphy's law will ensure that the simplest things have the highest stuff-up rates!

All's well? — now you attach the output coax cable to the underside of the board, plus the DC input and ground (0 V) wires. *But* — before you do, slip the output end piece of the probe case over the cable and supply wires, push it down about 150 mm or so and then slip the case of the probe case down the wires. This saves slipping them over the other end of the whole business and sliding them all the way to the probe.

The probe tip can be attached and soldered in place last of all. Now you can screw it all together and attach the appropriate plugs to the other end of the cable and supply wires.

With the construction completed, you can power up and try it out. Note that the transformer suggested in our power supply is but one of many suitable types. Any transformer that will deliver at least 26 V AC at a load of about 50 mA will suffice. Alternatively, any dual polarity DC supply having an output between 18 and 22 V at 250 mA will power the probe.

Note

Always take care that you don't exceed the input voltage limitation; LH0033s are expensive.

PARTS LIST

Resistors (all ¼ W, 5%)		**Semiconductors**	
R1	47R	IC1	LH0033CG
R2, R3	68R	IC2	78L15A
		IC3	79L15A
		D1-D4	1N4001,2,etc. (if required)
Capacitors			
C1, C3	3u3 16 V solid tantalum axial leads	**Miscellaneous**	
C2, 4, 5, 6	10n ceramic block		
C7, C8	10u 25 V tantalum		
C9, C10	470u 35 V electrolytic (if required)		

Miscellaneous: PCB (double-sided fibreglass); RG58U coax cable and BNC plug; T1 — (if required) 240 V to 30 V transformer or similar; optional 10M/¼ W 5% resistor and 2 x 1N914 diodes; wire; probe housing.

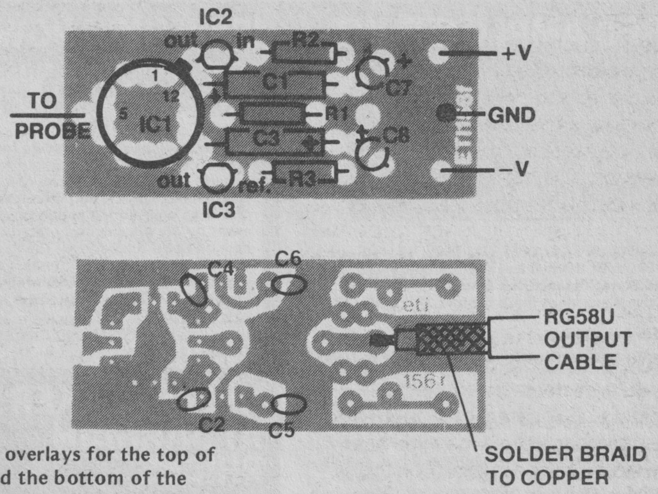


Fig. 2 Component overlays for the top of the board (top) and the bottom of the board (bottom!).

HOW IT WORKS

This instrument probe employs a wideband hybrid voltage follower/buffer IC, the LH0033, with very close to unity gain, that features a very high input impedance and a low output impedance. It requires regulated, well-bypassed supply rails. Two three-terminal low power regulators provide plus-and-minus 15 V supplies from an unregulated input.

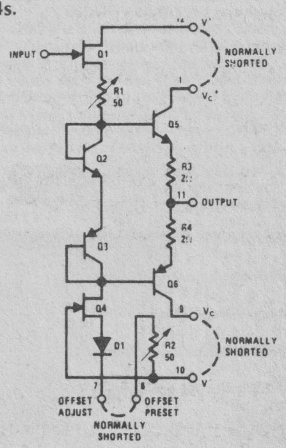
The internal circuit of the LH0033 is shown below. Basically, it consists of a FET input stage (Q1), operated as a source follower. The other FET, Q4, provides a constant current source for the source bias of Q1, while Q2 and Q3 are connected as diodes and provide bias for the bases of Q5 and Q6. Resistors R1 and R2 are laser trimmed in manufacture so that the IC meets the offset voltage specification. As Q1 has a constant current source load, the input impedance at the gate of Q1 is very low. The output of the source follower drives a complementary pair output stage, Q5-Q6. Thus the IC will have a very high input impedance, a very low output impedance and a gain very close to unity. With appropriate construction employed for the internal devices, the bandwidth over which the device will operate can be made very wide indeed. The −3dB point for the LH0033 is 100 MHz.

As the device is direct-coupled, DC levels will be maintained between input and output.

Bypassing requirements for the IC's supply leads are explained elsewhere in the article.

To provide regulated plus-and-minus 15 V rails for the IC, two three-terminal regulators are employed, a 78L15A for the positive rail and a 79L15A for the negative rail. These can supply up to 100 mA and have a very low output impedance up to several hundred kilohertz, which is exploited for low frequency bypassing. Each supply rail requires an unregulated input of between 18 V and 22 V. Decoupling of the supply leads provided by R2/C7 on the positive rail and R3/C8 on the negative rail. The input terminal of each regulator is bypassed to prevent instability.

As the input voltage is limited to a maximum equal to the supply rails (high impedance load), input protection may be added in applications where only low level signals are being examined. As shown in the main circuit, this protection consists of two 1N914 diodes connected back-to-back in parallel with a 10 M resistor across the input. Signals above 1 V peak-to-peak will be clipped, preventing any damage to the IC. If very fast rise time signals are to be examined then better protection for the IC can be obtained by using hot-carrier diodes such as the HP 5082-2800 instead of the 1N914s.



BUYLINES

Ceramic chip capacitors and solid tantalum axial capacitors are a trifle unusual; however, they are stocked by C.T. Electronics (Action) Ltd, 267 & 270 Acton Lane, London W4 5DG. (They also stock the BNC plug should you have any problems there). We will be selling the double-sided board through out PCB Service — the order form is on page 44.

LOOK

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire.

Self-assembly simulated wood cabinet. £4.50 + £1.50 p+p.

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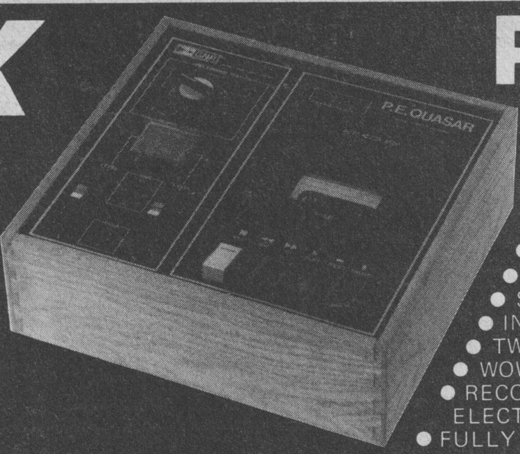
Featured in April issue Practical Electronics, reprint 50p - Free with Kit.



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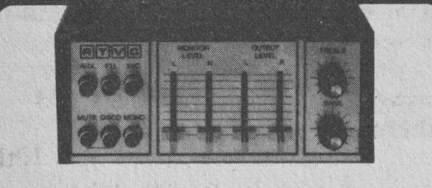

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£16·50 + £2.90 p&p.

SPECIFICATIONS:	Suitable for 4 to 8 ohm speakers
Frequency response	40Hz — 20KHz
Input sensitivity	P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls	Bass ±12db @ 60Hz Treble ±12db @ 10KHz
Distortion	0.1% typically @ 8 watts
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ACCESSORIES: Suitable mains power supply kit with transformer: **£7.50** plus £3.15 p&p.
Suitable LS coupling electrolytic: **£1.00** plus 25p p&p.

SPECIFICATIONS:
Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @ 100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

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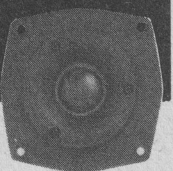

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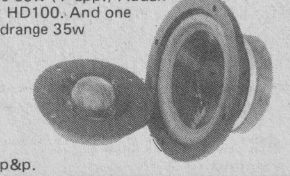

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PER SET + £2.70 p&p.

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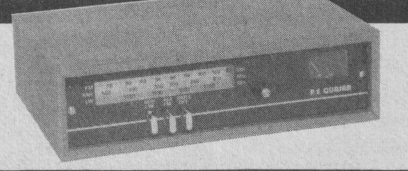
This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July 81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System. **FEATURES:** VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size: 10½" x 2½" approx. Complete with diagram and instructions.



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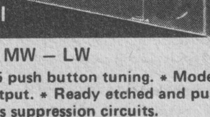

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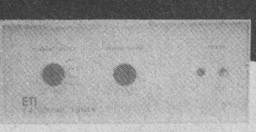

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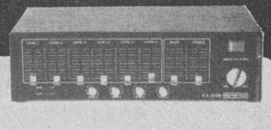

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50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls — six for level and two for master bass and treble, four extra treble controls for mic. and aux inputs. Size: 13¼"x 6½"x3¾"app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

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Write your name, address and answers on the form on page 133 (there's no need to cut up this page) and send it to us by April 30th, 1982. (All right, you can put your hands down now!)

RULES

1. Closing date is April 30th 1982, and all entries post-marked later than this date will be discounted.
2. The coupon provided in the magazine must be used. Photocopies are NOT acceptable.
3. Employees of ASP and their relatives are not eligible for entry.
4. The judges' decision is to be considered final and no correspondence will be entered into concerning the competition.

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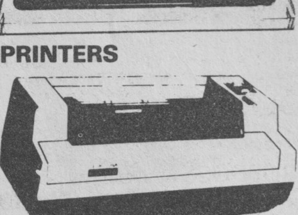

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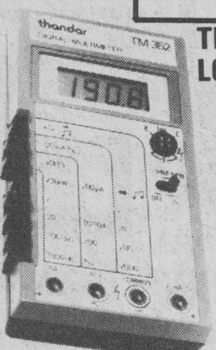

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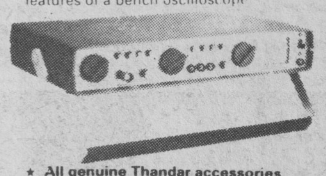

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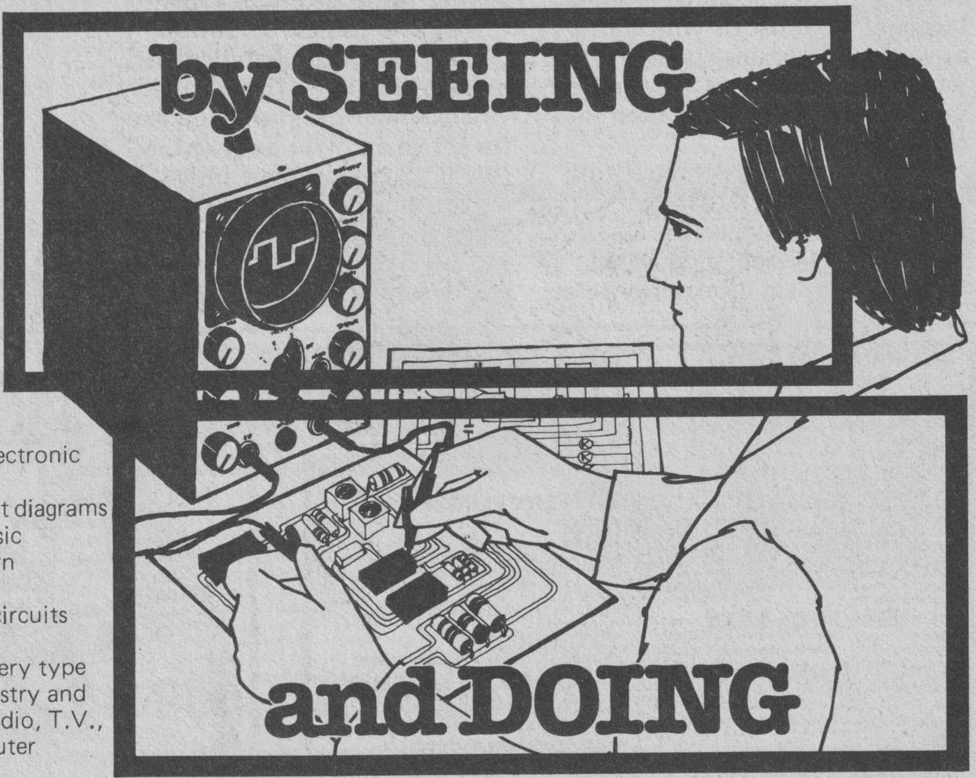

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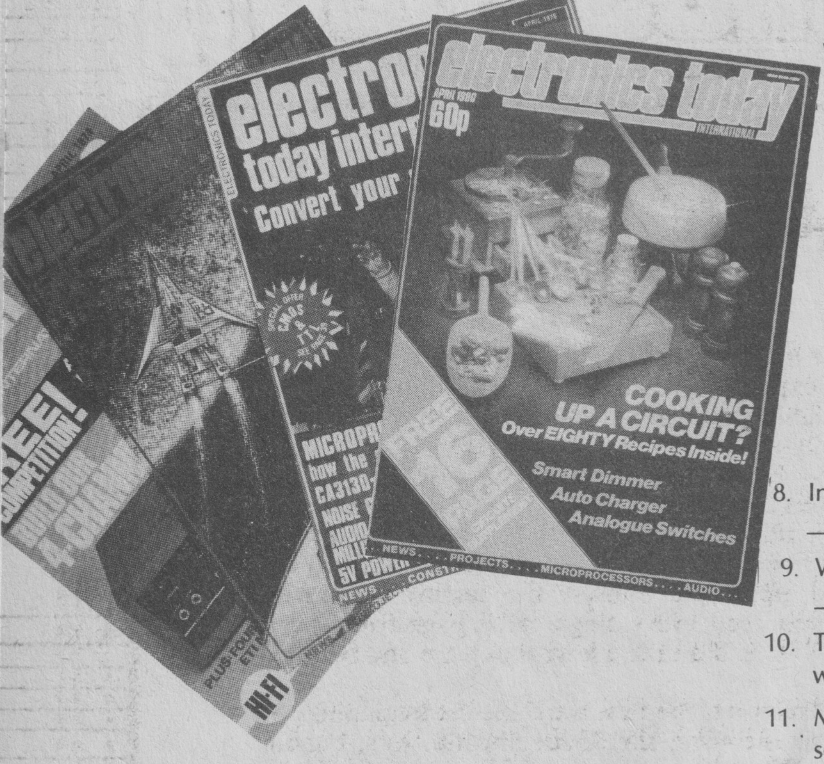

This is a special competition for our regular readers. We're offering a ten year subscription to ETI as a 'thank you' prize for supporting us this far. All the questions refer to back copies of our magazine and will be easy if you've kept the issues! (Surveys tell us that over 90% of readers keep ETI for longer than a year!) Index issues will be particularly useful, but will not give you *all* the answers. Fill in the coupon on page 133 — you don't need to ruin this issue — and don't forget your *name and address!* In the event that no one gets *all* the answers correct, the highest number of right answers will win. In the event of a tie, it will be the earliest postmark that takes the ten year subscription.

Read the questions carefully before answering.

1. Which issue was designated a "4 Channel Sound Special Issue"? ____________________
2. Who edited the May 1973 issue of ETI? ____________________
3. What month did the first issue of ETI appear in Britain? ____________________
4. What makes March 1979 good theatre? ____________________
5. ETI published the first-ever TV games project. In which issue? ____________________
6. Which IC is featured in the July 1976 "Data Sheet"? ____________________
7. The amplifier on the cover of the February 1982 issue has also appeared on a previous cover of ETI. Which one? ____________________
8. In 1979 who reviewed Star Chess for ETI? ____________________
9. Who first wrote the series "Electronics Tomorrow"? ____________________
10. The 100 W Guitar Amplifier (the first one!) appeared when? ____________________
11. Microfile is the title of ETI's regular computing hardware section. In which issue did it first appear? ____________________
12. In what year did we publish a synthesiser, an LED multimeter and an FM tuner in successive months? ____________________
13. What was "The Beast"? ____________________
14. How many parts of the popular "Electronics — It's Easy" series were published in ETI? ____________________
15. How many editors has ETI had in the past years? ____________________
16. In October 1976, who was ETI's Assistant Editor? ____________________
17. Who designed the Transcendent DPX? ____________________
18. Which issue began "Project 80"? ____________________
19. The 4600 synthesiser is one of our all-time most popular projects. In which issue did the series begin? ____________________
20. DIY Polyphonic keyboards came to ETI when? ____________________

RULES

1. **Closing date is April 30th 1982, and all entries postmarked later than this date will be discounted.**
2. **The coupon provided in the magazine must be used. Photocopies are NOT acceptable.**
3. **Employees of ASP and their relatives are not eligible for entry.**
4. **The judges' decision is to be considered final and no correspondence will be entered into concerning the competition.**

ISSN. 0142-7229

electronics today INTERNATIONAL 1972 - 1982

10 YEARS ON

The last ten years have been the most dramatic in the history of electronics. Tracing back, you can chart the explosive growth of the "consumer electronics product" from the first — highly expensive — calculators, through digital watches and the like — to the fully-equipped home computer.

When compiling this issue — ETI's 10th Birthday, as I'm sure you've noticed by now — it occurred to us that we had the entire course of electronics charted out for us — within the news pages of ETI! News Digest has always figured very highly in our readers surveys and companies mentioned therein have often commented upon the interest the feature generates.

Accordingly we went back and read every single news page from April 1972 through to April 1982. (Yes, it did take a long time). Lo and behold! History unfolded!

It was all there — the first calculators, the first watches, the beginnings of LCD, the first MPU chips, cheap memory, the Space Shuttle tests, bubble storage announced — and failed, CB radio underway, FETs on the hobbyist market, CMOS finally becoming cheaper than TTL — and the lunacies! We found quite a few of those, in fact. Witness the Queen's speech that wasn't and the TV game with ball-bearing scoreboard.

You will find them all in the following pages, the successes, the failures, the achievements...and the gaffs. We have gone through the mountain of material available and put together what we think is a truly historic collection. (Sounds good that doesn't it — should be in the British Museum.)

Reading through you will be presented with the fascinating and surprising history of electronics, 1972—1982. Check the dates each item appeared. Some of them will astound you. When was the first TV game on sale? The first LED watch? When could you buy a home computer in the UK? As to the ladies who crop up all the way through, we've no idea how they got there — they've nothing to do with us and they are most certainly not included just because we thought you would enjoy seeing them again. Enjoyment has got nothing to do with it.

It is an interesting conjecture as to what we will be able to include in our 21st Birthday Issue. Any guesses?

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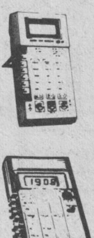

Callers will always find a range of low cost test equipment, accessories, tools, irons and boards in stock, also special offers for certain equipment which will vary from time to time.
Price correct at time of preparation E&OE.
All prices include VAT.

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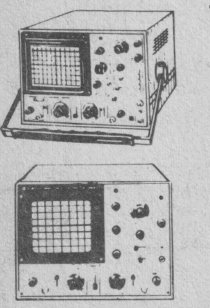

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CS1820 20 MHZ; 2-5mV 1 micro delay sweep	£483.00
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CS1575 5 MHZ, 1mV, 0.5 micro sec. Multi display Audio scope.	£312.80

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CO1303D 5 MHZ, 10mV, low sweep for observation below 1 HZ and up to 450 MHZ. 75mm display (UK c/p £2.00)	£124.20

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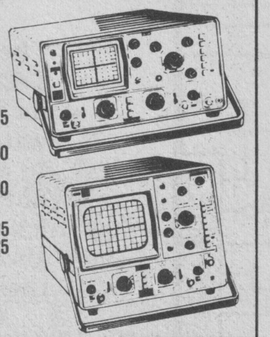

Range of Portable Scopes mains and battery operated.
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3131 Dual trace 15 MHZ, trg to 35 MHZ, 5mV, 0.5 micro sec. 130mm tube, plus component tester.	£264.50
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3337, dual MHZ, 130mm	£408.25

STOP PRESS
Model 3035 was £189.75 – **Special Offer £168.50**

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0/40KV: 20K Volt **£18.40**

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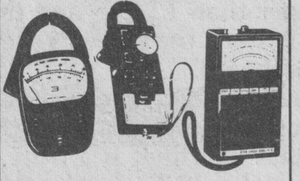
CLAMP-ON-METERS INSULATION TESTERS



Multi-range clamps all with resistance range, carry case & leads. Also digital and DC clamp in stock (UK c/p **75p**)

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K2803 300A, 600V, AC 9 ranges	£59.95
K2903 900A, 750V, AC 9 ranges	£77.50
K2103 1000A, 750V, AC 9 ranges	£95.00
*Optional temperature probe	£13.80

ELECTRONIC INSULATION TESTERS
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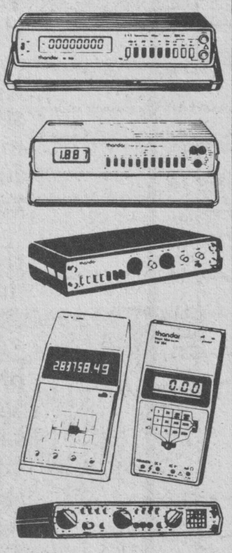
K3103 600V/100Meg. Plus 0-2.6K ohm	£109.00
K3106 500V & 1000V, 1000 & 2000Meg.	£119.00
K4101 Earth resistance tester	£149.00
M500 Hand cranked insulation tester 500V/100Meg.	£79.50

THANDAR – SINCLAIR



Reliable low cost portable instruments, bench models all 25.5 x 15 x 15cm. Generators mains operated rest battery (supplied). UK c/p Hand models 65p. bench **£1.15**)

DIGITAL MULTIMETERS (3½ digit LCD)

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TF200 Bench LCD. 200 MHZ. 10-30mV (600 MHZ with (TP600))	£166.75
TP600 600MHZ ÷ 10 Prescaler 10 mV	£43.13

GENERATORS (All bench models) mains operated

TG100 Function 1HZ-100 KHZ. Sine/SQ/Triangle/TTL	£90.85
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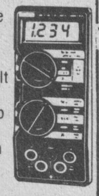

Model 130, 25 range. Easy to hold and use LCD DMM. Size 7 x 3.1 x 1.5

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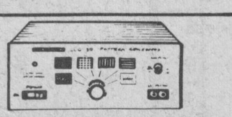
AC current 2mA-10AMP 2% 1 micro amp
Resistance 200 ohm-20 Meg 0.5% 0.1 ohm
£102.35



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LOGIC PROBE (UK c/p 45p)

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TV GAMES COME OF AGE

It is just over two years since the first TV games started to appear in pubs - since then a lot has happened in this field with a large number of small companies marketing various units by a variety of methods. Although the TV games have received a considerable amount of publicity they have not yet caught on in a big way.

"No one who has ever played TV games has ever said anything derogatory about the concept", Richard Fairhurst of Videomaster Ltd., told ETI, "they may not like the price or the packaging but they always like the idea".

ETI NEWS NOV 1975

bbc get it taped

The BBC and 3M have collaborated to develop a new tape recording system claimed to provide 90 dB noise figure. The system will accommodate 32 tracks on one-inch tape at an undisclosed tape speed.

ETI NEWS JULY 1973

PIEZOELECTRIC HEADPHONES

The Pioneer SE-700 are the first high fidelity headphones to use the piezo-electric effect. As the audio signals reach the headphones, the driver elements of ultra-thin aluminium-coated high-polymer film expand and contract accordingly, creating "breathing" motion. Tonal characteristics are comparable to those of the electrostatic type headphones, but the SE-700 require no matching transformer.

ETI NEWS MAY 1975

its a wide word

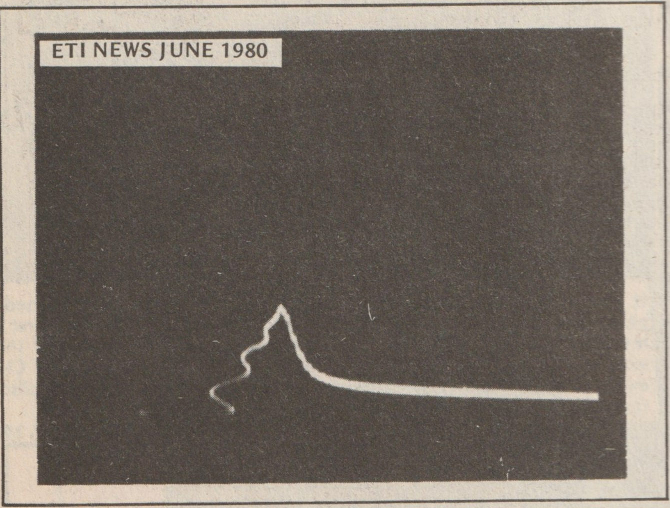
Intel, Zilog and Motorola are taking their places in the front rank on the grid for this years expected race to 16 bit MPU sales. All three have completed development, and will probably show the nature of their teeth at next months US Solid State Circuits Conference. The pause between this and letting loose of the hounds as it were will almost certainly mean late autumn production.

On yer marks ....

ETI NEWS MARCH 1978

Doctor Who

One of our readers, Mr. S. Knowles of Hampshire, sent us a scope picture he took whilst designing with a Textronix 7403 on 500 nS/div with x10 expand. It seems he was looking for a pulse, but he may well have discovered the secret of time travel!



ETI NEWS JUNE 1980

Pet Chip

This should appeal to those of you who spent your hard-earned pennies on a 'pet rock,'

We recently received a letter from an anonymous dad who made an apparently trivial Christmas presi for his daughter. However, since then he has been inundated with orders.

Mr A. Nonymous painted a face on one end of an IC (pet IC, you see) and made a matchstick cage for it complete with watch battery feeding bowl.

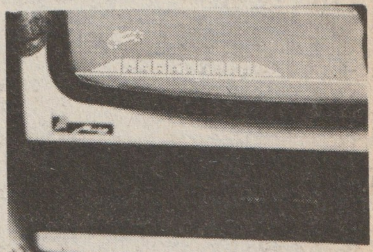
The chip should quickly LATCH on to its new OHM. As for feeding, a few BITS of CURRENTS a day should be AMPle. Just let it NOR away to its heart's content. You can teach it tricks.

Ta, Mr Nonymous. We haven't had a good groan in ages.

ETI NEWS MARCH 1980

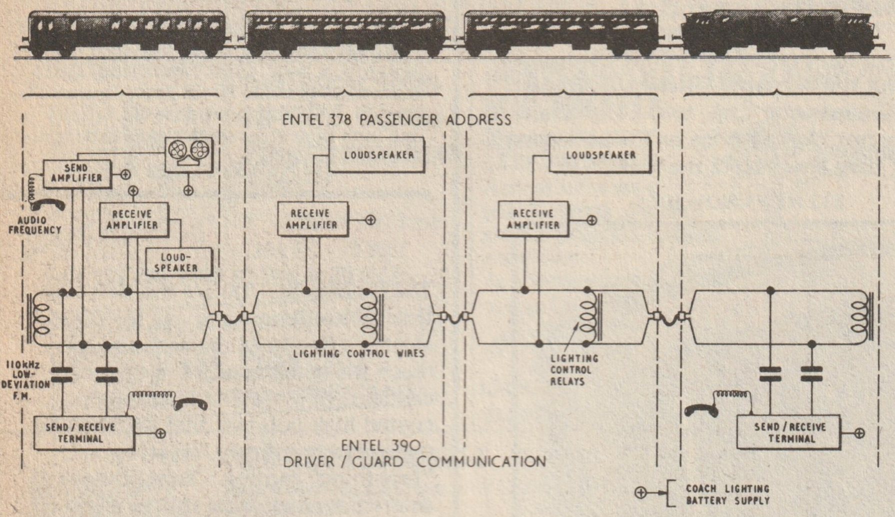
SHORTS

- Every Ready — now called Berec — have released four rechargable consumer batteries, in the HP2, HP11, HP7 and PP3 varieties. Chargers are also available. An undoubted reaction to the phenomenal loss of dry cell power these days.
- Direct drive turntables yes. But direct drive MPUs? Also yes — now. The S2000 is a new release from AMI which can drive flouorescent displays directly, with HT drive and 7-segment decoding on chip. Also on board 64 x 4 RAM and 1K ROM. Intended for low lost applications.
- Ingersoll — the tick tock people — are into electronics. They have released three TV games, three clock radios, two Door Chimes, and a portable micro cassette player. Photo shows one of their new TV games. It must be Christmas.
- Fairchild are making a big fuss about having their F16K Dynamic 16K RAMs available at last. Access times vary from 150 ns to 300 ns.



ETI NEWS JAN 1979

TALKING IN TRAINS



British Rail's plans for 150 mph trains include improved communication systems between drivers and guards. Also planned are passenger address systems.

A range of equipment — known as EMTEL — has been designed specifically for this task by Britain's Nelson Tansley Ltd.

The main problem to be overcome was the impossibility of providing a special cable, running the length of the train, on which to carry the signals.

The equipment was therefore designed to accommodate any continuous circuit, for example, the control wires for the lighting relays which (in British Rail), are the only conductors always connected throughout any passenger train. In this case, departure from the ideal of a 600 ohm noise-free line is caused by the connexion across the wires of many relay solenoids, the impedance of which is not only complex, but variable.

ETI NEWS JULY 1972

LASER MISSILE INTERCEPTOR

The US armed forces may soon have a laser missile interceptor. Air Force reports state that prototype deuterium fluoride lasers have been successfully tested at 'very very high' power outputs.

Power output is apparently so high that the laser beam burns straight through heavy gauge stainless nickel steel plate.

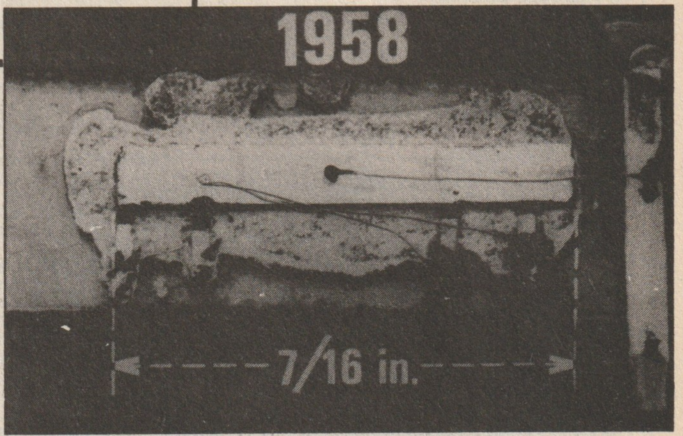
ETI NEWS JULY 1975

BIAS — AUTOSELECTION

Cassette tape recorders that have been designed specifically for use with chromium dioxide tapes require special bias switching facilities.

At present this is done manually. However the latest BASF 'SM' chromium dioxide cassettes have a notch on the rear of the cassette (in addition to the tab now used to prevent erasure of recorded material) and, hope BASF — and Philips who are backing the system — future cassette players will have a switch mechanism actuated by this tab to bring in the necessary bias circuitry.

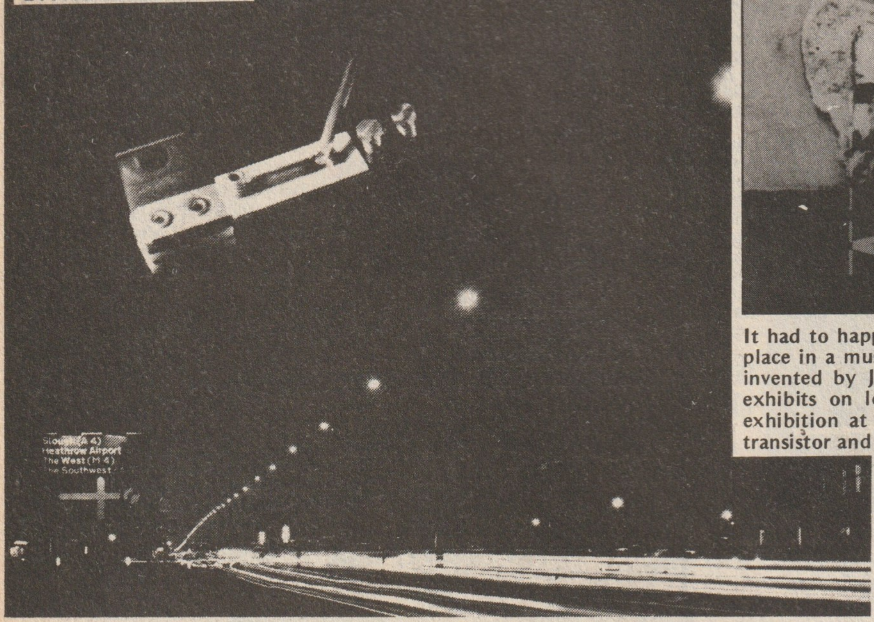
ETI NEWS APRIL 1972



It had to happen. The integrated circuit is so old that it has earned its place in a museum. Doesn't it make you feel old? The world's first IC, invented by Jack Kilby of Texas Instruments in 1958, is one of three exhibits on loan from TI in Dallas for the 'Challenge of the Chip' exhibition at the Science Museum. The other two are the first silicon transistor and the first single chip microcomputer.

ETI NEWS MAY 1980

ETI NEWS APRIL 1974



LIGHTING THE WAY

Many local authorities are now using a street lighting control system in which a photoelectric cell measures the light level and varies the input to a thick film heating element controlling a temperature sensitive switch. The street lights are therefore automatically switched on at dusk and off at dawn, which means that light is provided only when it is needed and ensures that electricity is not wasted.

GETTING READY FOR COMMERCIAL RADIO

Commercial radio is on its way; anyone doubting this should tune around the medium wave band where tests transmissions are already being conducted. Contracts for the supply of the transmitters and the aerials have been placed with EMI, the value of the order is put at £160,000.

ETI NEWS MAY 1973

shorts

- Tandy is doing well with its home computer in the USA, and is expanding, both physically and financially, that side of the business.
- New from GI — the Cricket chip. The AY-3-8910 is a programmable sound generator and is software controlled, needing only a power supply and clock to begin chirping or hooting or . . .

ETI NEWS OCT 1978

Hong Kong King

Some numbers to tick off on your fingers. In the first six months of the year Hong Kong exported 16 million watches (worth £77m). These break down as 61% mechanical, 29% LCD and only 10% LED and quartz analogue combined. Surprising LED figures eh?

Germany developed a sudden lust for these non-tockers and their imports leapt up by 287%, putting them as the second largest consumers — behind the US and ahead of us!

ETI NEWS NOV 1978

forget who not?

You know we've quite forgotten why we used this photo at all. Now let's see something to do with TV games? Anyway the editorial desks have been bereft of nice lady photos lately — so this one appeared as an oasis amid the dusty filing trays.

P.S. Binatone the people who make the box in front — don't ask what box or in front of what or we won't speak to **you** again — claim to now taken over half the TV game market — the magic 51% in fact.

ETI NEWS NOV 1978

BE WARNED (IN A SMALL WAY!)

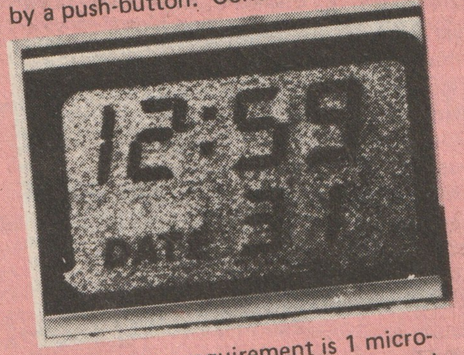
The Mini-Bleeptone 525 is a unit which provides a choice of two continuous signals of up to 80dBa with current consumption ranging from 3–15mA.

ETI NEWS JULY 1976

. Its applications are wide, being ideally suited as a fault indicator mounted onto portable equipment and instrument panels, or for localised warning of such things as intruders and/or fire

NEW LC DISPLAYS FOR WATCHES

A new series of Liquid Crystal displays have been announced by Beckman for digital watches. These display hours and minutes continually with either date or seconds, selected by a push-button. Contrast ratio is



20:1. power requirement is 1 microwatt so that even with constant readout battery life is over a year. LC modules are available for both 3V and 6V models and a CMOS compatible.

Beckman Instruments Ltd., Queensway, Glenrothes, Fife, Scotland.

ETI NEWS OCT 1978

Pocket Companion

Not just an electronic dictionary or a translator or an appointments diary or an encyclopedia, but something of all these rolled into one, the 'Brainbank' is hailed as the world's first pocket information centre and language laboratory.

Brainbank is programmed via a series of interchangeable. plug-in memory cells, so you have virtually unlimited information storage possibilities (armed with a bucket full of memory cells).

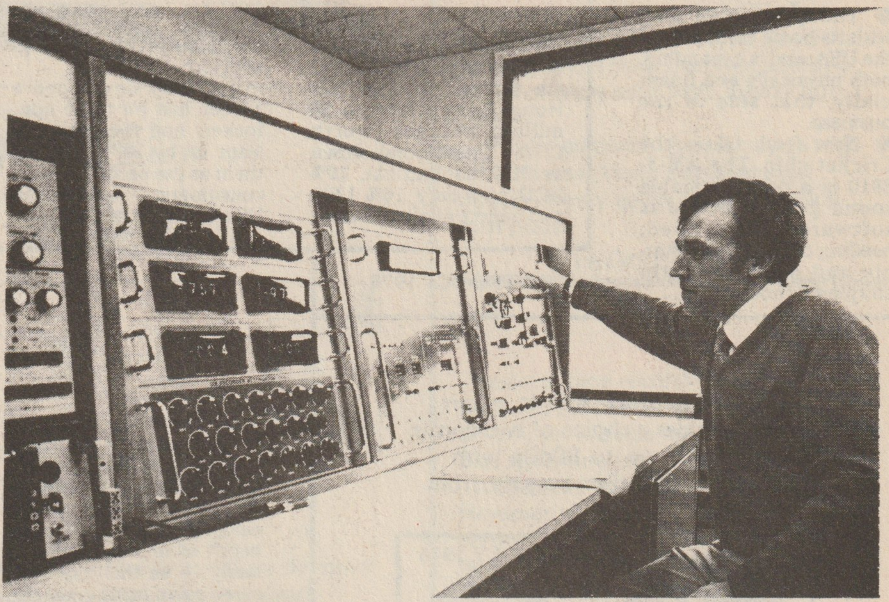
Each language cell, which contains 32K of ROM holds about 1200 of the most common words, stored individually and in groups of up to fifty in categories such as travelling and food. The program also includes short phrases, automatically corrects spelling errors and explains words with double meanings (with its double entendre chip?).

The information centre's heart is a Mostek 3870 microprocessor. Memory cells are currently available on diet and nutrition, first aid, taxation and a thesaurus. New cells will become available every month. A custom cell service is also available.

Brainbank will cost around £150 plus £20 or less for each additional cell. We will tell you more about this little marvel, when we can get hold of one to play with.

ETI NEWS JAN 1980

300 MPH HOVERTRAIN – PUBLIC SHOWING



ETI NEWS APRIL 1972 (OUR FIRST EVER NEWS ITEM!)

Computerised control and data recording equipment that can handle information from up to 413 different sources will be used in the development of Britain's tracked hovertrain – during its period of full-scale development.

From this console, commands will be transmitted by radio to the hovertrain and radioed signals from the measuring instruments inside the vehicle will be received, recorded and analysed.

The 25-ton vehicle straddles the track and is supported approximately an inch above it by a system of fans employing the hovercraft principle. The linear motor consists of an aluminium strip set into the top of the track as the motor's "stator", and a complex set of electrical windings mounted inside the body shell. Power is picked up from a trackside rail.

The train made its first run over a mile of the track recently, watched by visiting experts and the press from several countries. It performed perfectly during the slow-speed run and is now expected to reach speeds of up to 90 mph during the next two months.

The hovertrain has been designed and constructed by Tracked Hovercraft Ltd., a company set up by Britain's National Research Development Council, and would be capable of providing a link between central London and the airport planned for Foulness, its passengers completing the journey in quiet pollution-free comfort in about 20 minutes.

RED TAPE GAGS THE QUEEN!

In the wee small hours of January 19th 1903, Marconi established the first two-way communication across the Atlantic. Messages were exchanged between the American president Theodore Roosevelt and the British King Edward VII. To mark the 75th anniversary of this event, the Cornish Radio Amateur Club have organised a team of sixty local amateurs to run GB3 MSA (Marconi's Seventy-fifth Anniversary). The station was run 24 hours a day, from the 14th to the 22nd January, from the lounge of the Poldhu Hotel in sunny Cornwall – only metres away from the spot Marconi used.

Transmitting on 80m, 20m and 2m the team had already made 1 100 contacts in 51 countries when ETI contacted them on the 16th! All the equipment was owned by the club and its members and set up for the week specially. On the American side was another station, KM1 CC, based in Cape Cod. KM1 CC was run by the local Barnstaple, Mass. radio club with the help of the Radio Club of America.

Now for the red tape . . President Carter sent a message via KM1 CC and the Queen wanted to send a reply via GB3 MSA, just like Edward VII did back in 1903. The Home Office said that if she did, it would break a condition in all British amateurs licences – namely the one about not passing on messages from 3rd parties! So after 2 years preparation the Cornish Amateurs and the Queen were denied permission to reply to President Carter.

ETI NEWS MARCH 1978

Something Bugging You?

ETI NEWS OCT 1980

With the increase in telephone tapping and boardroom bugging, Audiotel International have developed a simple to use, yet sophisticated successor to their Scanlock radio surveillance receiver. It is called the Scanlock Mark V8 and is a fast, easy means of detecting and locating an eavesdropping transmitter as well as being capable of routine 'sweep' searches of high level meetings rooms. Carried in a vehicle it can also locate any bleeper bug used for 'trailing'.

The Scanlock is not limited to the conventional radio receiver's range of 88-108 MHz. It covers the wider frequency spectrum of 10-1800 MHz and its automatic 'sweep' mode scans this range four times a minute. Finally all that is necessary is to press the 'Locate' button and use the hand-held wand to guide you to where the bug is located. The kit is the size of a small briefcase, weighing 6.3 Kg, complete with spare battery pack. There is also provision for mains usage. For further information contact Audiotel International Ltd at Saddlers Court, Yately, Surrey, GU17 7RX.

CONCORDE BAN?

Whilst we are currently bombarded with PR material extolling the 'virtues' of the Concorde supersonic airliner it is interesting to note that in the USA Senator Alan Cranston has introduced a bill, co-sponsored by Senators Edward Muskie and Caliborne Pell, to prohibit overseas supersonic transports from landing at any US airports or flying over US territory at supersonic speeds.

The SSTs which carry less than half the passenger load of a 747 make ten times as much noise on take-off and landing. ETI NEWS JULY 1972

RICE LOGIC?

Later this summer – about June – National Semiconductor and Kellog's are to hook-up on a promotional deal. All Kellog cereal packets will carry coupons for reductions on National calculators. Barley credible is it not? ETI NEWS JULY 1976

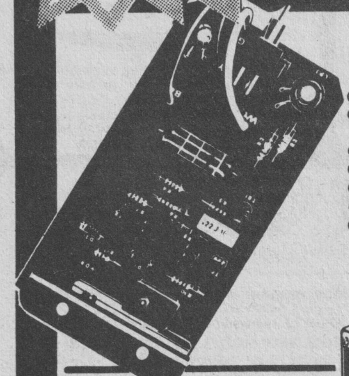
breadboard '78

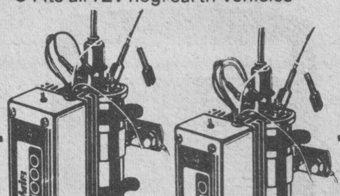
At long last a show for the electronics enthusiast – Breadboard '78 will be held at Seymour Hall in London from the 21st to 25th of November – mark it in your diary now 'cos ETI will be exhibiting! If you are a firm and would like more details contact: Breadboard '78, Abbey Mead House, 23a Plymouth Road, Tavistock Devon PL19 8AU.

ETI NEWS JUNE 1978

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

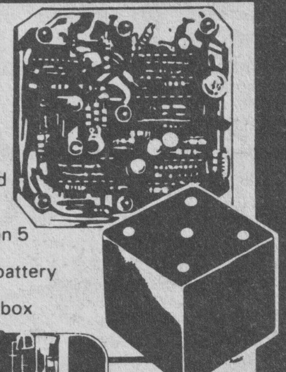
Sparkrite
BRANDLEADING ELECTRONICS
NOW AVAILABLE IN KIT FORM

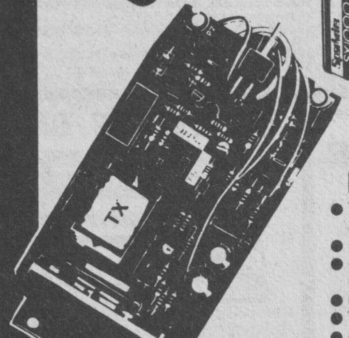


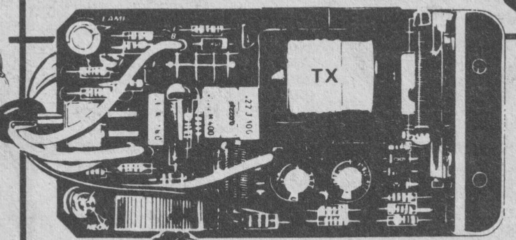


SX1000
Electronic Ignition
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

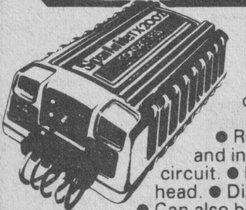
MAGIDICE
Electronic Dice
- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and Off switch on base
- Hours of continuous use from PP7 battery
- Over 100 components to assemble
- Supplied in superb presentation gift box



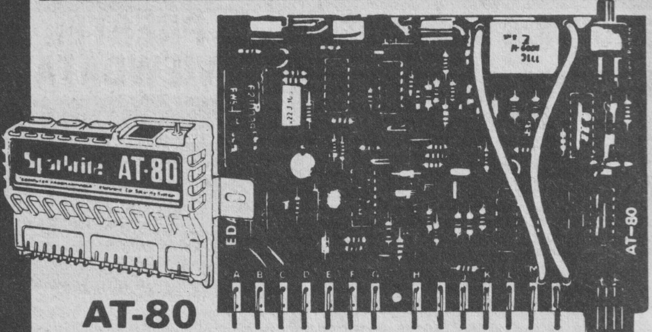




SX2000
Electronic Ignition
- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



TX2002
Electronic Ignition
● The ultimate system ● Switchable contactless. ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor trigger-head. ● Distributor triggerhead adaptors included. ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble



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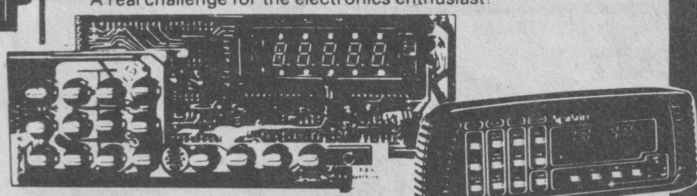
● A most sophisticated accessory. ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd. ● Affords 12 functions centred on Fuel, Speed, Distance and Time. ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on. ● Facility to operate LOG and TRIP functions independently or synchronously. ● Large 10mm high 400ft-L fluorescent display with auto intensity. ● Unique speed and fuel transducers giving a programmed accuracy of + or — 1%. ● Large LOG & TRIP memories. 2,000 miles. 180 gallons. 100 hours. ● Full Imperial and Metric calibrations. ● Over 300 components to assemble. A real challenge for the electronics enthusiast!

AT-80
Electronic Car Security System
- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble



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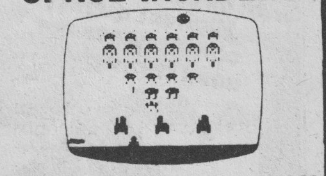
SPACE INVADERS



Hand-held Invaders Games available **£19.95**
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+ Cartridges also available for
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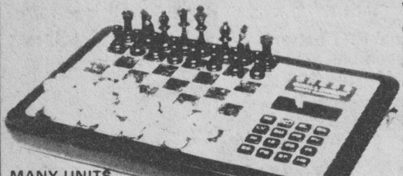

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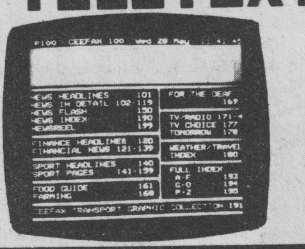
TELETEXT



ADD-ON ADAPTOR £199 inc VAT

THE RADOFIN TELETEXT ADD-ON ADAPTOR
Plug the adaptor into the aerial socket of your colour T.V. and receive the CEEFAX and ORACLE television information services.

THIS NEW MODEL INCORPORATES:
- Double height character facility
- True PAL Colour
- Meets latest BBC & IBA broadcast specifications
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- Unnecessary to remove the unit to watch normal TV programmes
- Gold-plated circuit board for reliability
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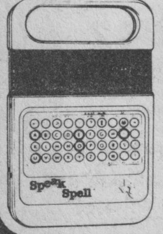
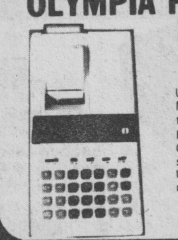


Normal Price £49.95
NOW REDUCED TO: £39.50 inc VAT

Teach your child to spell properly with this unique learning aid. Fully automatic features and scoring. Additional word modules available to extend the range of words.

ADDING MACHINE
OLYMPIA HHP 1010



Normal Price £57.21
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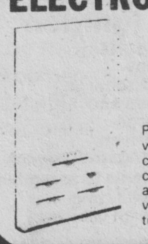
Uses ordinary paper! No need to buy expensive thermal paper!
Fast add listing PRINTER CALCULATOR. 2 lines per second, 10 digit capacity. Uses normal adding machine rolls. Battery or mains operated.
Size 9¼"x4⅝"x2⅜"
(Mains adaptor extra)

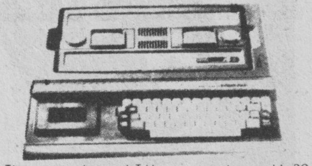
24 TUNE ELECTRONIC DOOR BELL



Normal Price £19.70
NOW REDUCED TO: £12.70 inc. VAT

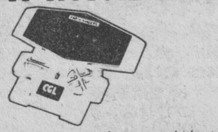
Plays 24 different tunes with separate speed control and volume control. Select the most appropriate tune for your visitor, with appropriate tunes for different times of the year!

MATTEL T.V. GAME



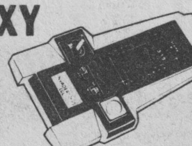
The most advanced T.V. game in the world. 20 cartridges available. Add on KEYBOARD coming soon to convert the MATTEL to a home computer with 16K RAM, fully expandable and programmable in Microsoft Basic. Other accessories will be available later in the year.
£199.95 inc VAT

HAND HELD GAMES
EARTH INVADERS



These invaders are a breed of creature hitherto unknown to man. They cannot be killed by traditional methods — they must be buried. The battle is conducted in a maze where squads of aliens chase home troops. The only way of eliminating them is by digging holes and burying them.
£23.95 inc. VAT

HAND HELD GAMES
GALAXY 1000



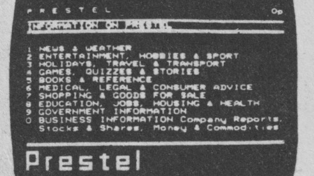
The 2nd generation Galaxy Invader. The invaders have re-grouped and have a seemingly endless supply of spacecraft whilst the player's arsenal is limited to just 250 missiles to be launched from 3 missile stations. You have to prevent the invaders landing or from destroying your home defences.
£19.95 inc. VAT

THE OLYMPIA — POST OFFICE APPROVED TELEPHONE ANSWERING MACHINE
WITH REMOTE CALL-IN BLEEPER

This telephone answering machine is manufactured by Olympia Business Machines, one of the largest Office Equipment manufacturers in the U.K. It is fully POST OFFICE APPROVED and will answer and record messages for 24 hours a day. With your remote call-in bleeper you can receive these messages by telephone wherever you are in the world. The remote call-in bleeper activates the Answer/Record Unit, which will at your command repeat messages, keep or erase them, and is activated from anywhere in the world, or on your return to your home or office. The machine can also be used for message referral, if you have an urgent appointment, but are expecting an important call, simply record the 'phone number' and location where you can be reached. With optional extra bleepers (£13 each) this facility can be extended to colleagues and members of the family. Using a C90 standard cassette you can record as many as 45 messages. The announcement can be up to 16 seconds long and the incoming message up to 30 seconds long.

The machine is easy to install and comes with full instructions. It is easily wired to your junction box with the spade connectors provided or alternatively a jack plug can be provided to plug into a jack socket. Most important, of course, is the fact that it is fully POST OFFICE APPROVED.
The price of £135 (inc. VAT) includes the machine, an extra-light remote call-in Bleeper, the microphone message tape, A.C. mains adaptor. The unit is 9¾"x6"x2½" and is fully guaranteed for 12 months. The telephone can be placed directly on the unit — no additional desk space is required.
£135 inc. VAT

PRESTEL VIEWDATA



The ACE TELCOM VDX1000 Prestel Viewdata adaptor simply plugs into the aerial socket of your television and enables you to receive the Prestel Viewdata service in colour or black & white.

Features
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- Special graphics feature for high resolution
- State of the art microprocessor controller
- Standard remote telephone keypad with Prestel keys * #
- Auto dialler incorporated for easy Prestel acquisition
- True PAL colour encoder using reliable IC chroma filter and dela line incorporated for minimum picture interference maximum fidelity
- Includes convenient TV/Prestel switchbox
- Easily connected to standard home or office telephone lines
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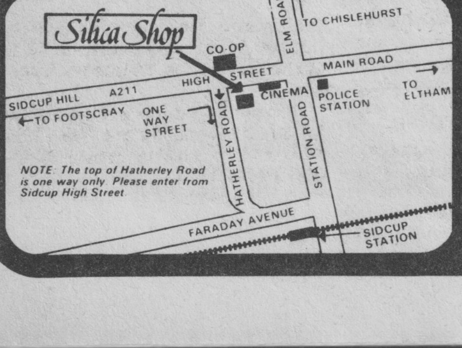

NOTE: The top of Hatherley Road is one way only. Please enter from Sidcup High Street.

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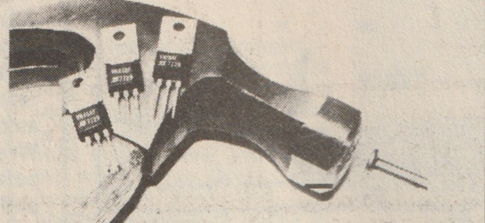
Telephone: 01-301 1111 or 01-309 1111

SILICA SHOP

hammer fet-ish

A new range of low cost VMOS power FETs in plastic have been introduced by Siliconix. These devices are aimed at replacing conventional bipolar transistors in a great many applications. This development in VMOS technology has cut the price of such devices by a third enabling them to compete directly with bipolar devices.



ETI NEWS APRIL 1978

CALCULATOR CHIPS NOW LESS THAN £1

Calculator chips prices continue their inexorable fall in price. Latest prices in the USA for four function eight digit MOS chips are now as low as 40p to 80p. Even the complex scientific calculator chips are down to £6 or less compared to £20 this time last year.

MOS Technology Corporation for instance are selling a single chip scientific unit for £7.

ETI NEWS JULY 1975

ETI NEWS DEC 1977

sailing into space..........

A 12 bladed solar sail spacecraft is a new candidate for mankind's first interplanetary shuttle. Designed to be employed in the 1980s its first use might well be a rendezvous with Halley's Comet in 1986.

The 'heliogyro' sail uses a helicopter type design with 12 'blades' composed of reflective aluminium plastic film, and deployed in two tiers of six each. After launch from the space shuttle, centrifugal force would open the blades to their 4½ MILE length. (They're 28ft. wide). The craft sits in the centre of the array.

The craft would be slowly spun by the sun's photon radiation, and complete a rotation every three minutes. A square sail, and hence windjamming to the stars, was rejected in favour of the blades, which now fight it out with an ion stream propulsion system for NASA considerati

ANTI-SKID CONTROL

The first standard i.c.'s designed specifically for the automotive market have been announced by Fairchild. Both are complex linear circuits developed over the past two years as 'custom' circuits before being added to the standard product line.

ETI NEWS OCT 1973

ELECTRONIC CHEQUEBOOK CALCULATOR

A pocket calculator that will hold and display bank cheque account balances for a year or more is shortly to be announced by the US Mostek Corporation.

During the times that the calculator is 'off' data is stored in a static shift register (drawing a mere 100 microamps). This data is then clocked solely when access is required.

The unit is expected to retail for less than £16 and will be built into a plastic chequebook holder.

ETI NEWS JULY 1975

BUBBLING OVER

Next year Rockwell are hoping to launch their now developed one-megabit bubble memory price? One millicent per bit!

Their device can operate up to 300kHz and measures 10 x 9.5mm and is designed for a 1.8 micron bubble diameter. ETI NEWS SEPT 1977

● Bowmar has Texas's range and is homing in. Texas are being sued for $3 million by Bowmar who allege the supply of a large number of defective calculator keyboards.

● XR4741 to you. Nothing to do with sci-fi but a new quad op-amp. Very low noise and better than a 741 in all respects. Available from RASTRA at 275 King St, Hammersmith, London W6. Ideal for audio projects where the hissing of summer circuits is not required.

● The Government's hi-fi firm, Strathem are to launch their new SM2000 turntable in the autumn, which will replace the SMA2 model. Once again the unit looks technically sound — maybe success at last for nationalised-fi?

ETI NEWS OCT 1978

ACC AFTER ONE YEAR

Now moving into its second year of existence the Amateur Computer Club has now formulised its activities into a constitution and has a membership of over 200. ETI NEWS AUG 1974

Power Cuts On The Way

In 1968 your 20 inch colour telly using 90° deflection would have consumed over 200 W. Now, the figure is around 65 W. A new development from Finland will further reduce that to about 40 W.

The system, which results in a reduction of about 40% in power consumption, has been incorporated in the Salora G Series of portable colour sets. The design is basically a 90% efficient couple between the power supply and picture tube using an induction transfer system. The resultant cool running improves reliability and extends operational life.

The G Series, with its 16, 20 and 22 inch models, will operate from a standard 60A/hour 12 V battery for 15 hours, or from mains for as long as you pay your bills.

All the models feature automatic electronic tuning, fine tuning and memory plus add-on options for remoted control, 12 V battery and video frequency interface unit.

Salora products are available in the UK from Salora (UK) Ltd, 25A Techno Trading Estate, Swindon SN2 6EZ.

SPACE SHUTTLE ON THE TILES

Extremely pure silica glass has been manufactured for at least 40 years - longer than jet aircraft have been around. Now it is to aid and abet the ultimate aircraft - the U.S. Space Shuttle. Made into tiles (composed of 96% silica glass) of which 34,000 are used, the material covers well over 70% of the surface of the Shuttle.

These tiles are incredible heat 'shedding' devices (see photo) and will be expected to withstand temperatures of up to 1260ºC for 100 re-entries into the atmosphere. Previous heat shields were destroyed on re-entry.

Each tile is precisely milled to fit exactly against the curvature of the Shuttle body, thus making the composite craft as light as possible, and as aerodynamic as is feasible. This does however mean that no two of those 34,000 tiles are alike! Imagine the little man in a white coat with the job of fitting them to the aircraft - a huge 3-D jigsaw puzzle with only one solution out of 34,000 (i.e. 34,000 x 33,999 x 33,998...x 1) possibilities! Rather him than me.

ETI NEWS MARCH 1977

ORACLE ON AIR

ORACLE, ITV's Teletext system (see ETI, July 1975) began an on-air experiment on the ITV network on 30th June. Operating the experiment are two editorial teams and three computer systems. At ITN there is an editorial team (plus computer) for news and associated information. At London Weekend Television there will be an editorial team preparing public service and similar information pages, and the second computer. At Thames Television the third computer will be used to insert data into the network during the Monday to Friday broadcasting period with LWT taking over for the weekend transmissions. It is hoped that there will soon be sets with decoders in the main entrace lobbies of ITN House, London Weekend Television's South Bank Studios and Thames Television's Euston Studios, so that visitors can interrogate the system and see how ORACLE works.

ETI NEWS SEPT 1975

WATCHES FACE COLLAPSE!

Five companies have dropped production of digital watches, due entirely to the price war raging around the product. Gruen, Benrus, Armin Litronix and Gillette have decided the wrist borne digit is not for them. Those still there are sufferin too. Bulova are expected to make a loss this year. Gillette in fact pulled out before they pulled in, scraping well laid plans to burst into the 'marketplace' at the eleventh hour.

ETI NEWS SEPT 1977

solid state speech

If the latest goodie from Texas Instruments is as successful as we think it will be, the next generation will speak with an American accent! Called "Speak & Spell' it is a box that talks to the kids (with a 'standard' American accent), and theoretically helps them pronounce new words correctly — it also compares how the kids spell the word with the correct (American) spelling, and indicates whether they gave the right answer.

ETI NEWS AUG 1978

£15 DOLBY RADIOS SOON?

Even the cheapest of domestic radio receivers may soon have Dolby circuitry inbuilt according to Alan Gregory of the Signetics Corporation, manufacturers of the NE545 Dolby IC chip.

Gregory believes that the inclusion of the chip (which will be sold to manufacturers for less than a dollar will increase the price of domestic receivers by a pound at the most.

ETI NEWS APRIL 1975

SCREEN TEST

The UK is now Hong Kongs largest market for TV games. We absorbed 26% of their export in the field, some 523,506 items if you please, in the first eight months of this year. Germany finished second on 22% and the USA came third with 13%.

Somewhat of a surprise, and a shame, that we take more than the States of these items. I always thought we had more taste.

ETI NEWS JAN 1979

A POCKET CALCULATOR IN EVERY HOUSEHOLD

"By the mid-70's the pocket electronic calculator will be as much an essential part of the household as the transistor radio is now". This is the prediction made by Sinclair Radionics.

Recent market research confirms that increasing numbers of the population are becoming aware of the possible applications of pocket electronic calculators. This is most marked in the educational field, at school and college levels although considerable interest is also being shown on the domestic front by husbands and wives who are able to use a calculator to help control the family budget.

ETI NEWS DEC 1973

THE END OF THE AMP?

A British invention (three cheers!) could well mark the end of the amplifier as a circuit block. A new device called a 'voltage-to-current transactor' can do everything an op-amp can – but better. Invented by Professor Gosling and Carl Brinker, the device contains no passive components at all, and consists of a network of transistors.

The advantages are that it integrates smoothly rather than as a series of steps, follows an input quicker and with a wider dynamic range, is smaller in chip form and uses less external components. A VCT can also double as a transformer!

ETI NEWS OCT 1976

Blonde Bombshell

Now be honest with yourself — aren't there times during those long cold winter days when you could do with one of these in your office. No, unfortunately I don't mean Blondie in the white pants. The blonde bombshells here are the brushed aluminium boxes of ITT Terryphone's new solid state intercom units.

The intercom, which doubles as a security and alarm system, consists of a master unit and from one to nine sub-units. The system is easily installed in many configurations.

Simple press-button-to-talk operation is featured on the master and sub-units. Each sub-unit can be called independently from the master unit, or all sub-units can be called simultaneously. Pressing the self-latching security button allows noises from children, equipment, burglars, etc to be picked up and transmitted to other parts of the premises. So, the intercom can be used as a security system in small businesses of a baby alarm at home.

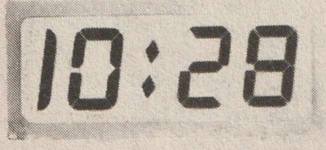
Each sub-unit comes complete with cable and cable fixing pads for £20 each. The master unit costs £85 and comes with a mains plug and a screwdriver. Talking of Blondie — she can install an intercom in my office any time.

Further details of this system is available from ITT Terryphone, Station Approach, London Road, Bicester, Oxon OX6 7BZ.

ETI NEWS JAN 1980

FIELD EFFECT LC DISPLAYS

Siemens incorporate the field effect principle in their new liquid crystal displays with low operating voltages.



All the liquid crystal displays in field effect technology have dark symbols on a light background and are suitable for reflection operation, all with high contrast ratios, low operating voltage and low power draw. Such features allow the displays to be driven by CMOS and other ICs.

ETI NEWS MARCH 1975

BANDING TOGETHER

The Editor,
Electronics Today International,
36 Ebury Street,
London SW1W 0LW.

Dear Sir,

We were most pleased to read the article "C.B. for Britain" in your July issue. The Citizens' Band Association is campaigning for the establishment of a VHF Citizens' Band in the UK and agrees with nearly all the points you make.

We have prepared a technical proposal for a VHF FM Citizens' Band which is being sent to the Home Office for discussion and contains a number of proposals to ensure that a British Citizens' Band suffers from few of the disadvantages of the American one. These proposals include:

1. Modulation shall be FM which avoids many problems of TVI, BCI and audio equipment break-in.

2. Each transceiver should contain an automatic identifying signal which is transmitted every time the transmit key is depressed. This means that anyone misusing Citizens' Band can easily be identified.

3. Transmission time should be limited to 75 seconds to prevent channels being monopolised.

Apart from the above, and a few purely technical proposals concerning standards which should be high enough to prevent interference to other services but not so unnecessarily high as to price Citizens' Band equipment out of the market, we believe that a British Citizens' Band should have a minimum of regulations.

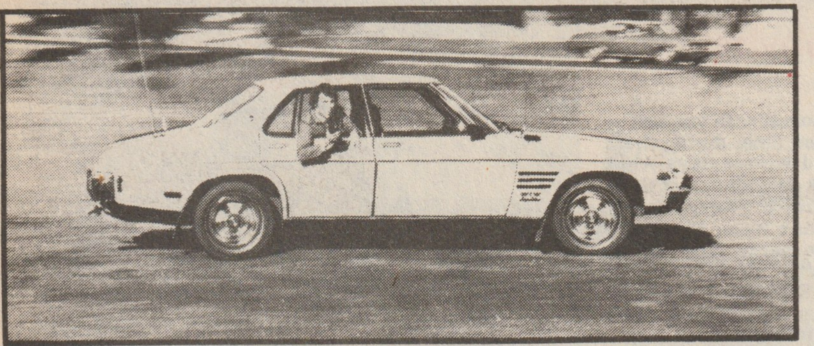
Membership of the CBA is £1.50 p.a. for individuals and £5 for clubs.

Yours faithfully,

James M. Bryant,
President, Citizens Band Association.

ETI NEWS OCT 1976

STEERING WHEEL? WOT STEERING WHEEL?



We had a very careful second look at this photograph, vowed to give up wine, women, and especially song, (for at least five minutes) then decided yes he was in the back seat, and yes the car was moving. Visions of a huge hoax flashed to the editorial mind — frenzied navvies rushing about with the backdrop to simulate movement — tiny men crammed into the wing mirrors steering via cunning Chinese arrangements of levers and gears. The mind boggled.

Alas the answer is nought so scandalous. Quite simply an Australian electronics enthusiast has packed his car full of voice recognition and MPU circuitry to the end that it will now obey verbal commands — even by walkie-talkie up to a range of 12 miles (Naturally it obeys only its owners voice).

The car has a CCTV system installed which enables the driver to see behind him — very useful in injon country. Infra red sensors pick up red traffic lights and brake the car automatically — no we're not joking. Radar ranging maintains a constant distance with respect to the car in front, and sensors apply the brakes should the car come too close to any object — even people.

All this makes it a better driver than most of us.

ETI NEWS NOV 1976

right hook

In a historic ruling, the US Supreme Court has confirmed that private individuals have the right to buy or make their own telephone equipment and connect it to the US telephone network.

Under the ruling it will be legal to hook up as many devices as the user wishes — computer controlled systems, 'phone diverters, memory diallers, picturephones etc, etc. The only restriction is that the various bits must meet the relevant FCC requirements.

ETI NEWS APRIL 1978

DIGITAL RECORDING

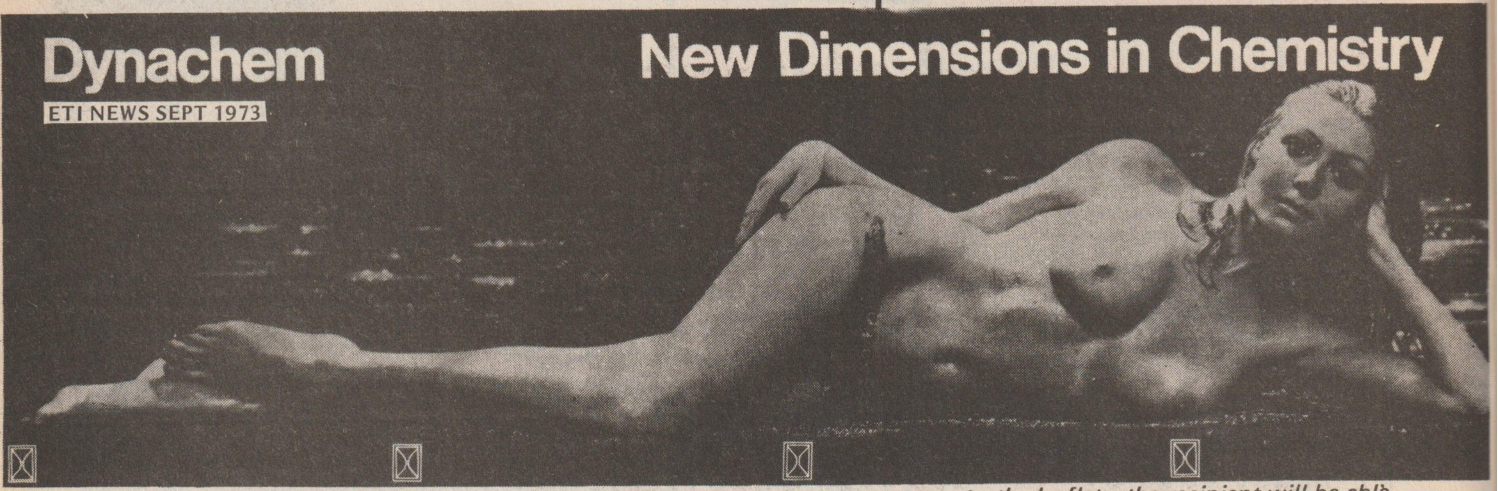
Japan's Nippon Columbia company have developed a digital recording technique. The new equipment, said to cost over £125,000 uses pulse code modulation.

Advantage of this technique is its virtual imperviousness to noise and distortion. Further details will be published as they come to hand.

ETI NEWS JAN 1973

LASER STICK FOR THE BLIND

A stick specially designed for blind persons gives the bearer a loud sonic signal in the event of impediment in his path at wrist height or above. The new device was commissioned by the Swedish Institute forthe Handicapped and work on the project was initially financed by the Swedish Board for Technical Development (STU). The prototype stick comprises a 1.3-metre-long tube made of glassfibre-reinforced plastic. To it is attached a gallium-arsenide laser, a midget transmitter and receiver, and an amplifier. The power source is a tiny nickel-cadium accumulator. The laser beam's trajectory is almost at right-angles to the stick's length, and as such sticks are normally held forward at an angle of about 45 degrees to the ground, the beam is directed both upward and forward. The laser sends about 1000 pulses per second and when one of these meets an object — such as a lorry, car or a road sign — it is reflected back to the stick, where it is electronically transformed into a sonic warning signal to alert the bearer. ETI NEWS NOV 1972



GIRL BY INSTALMENTS!

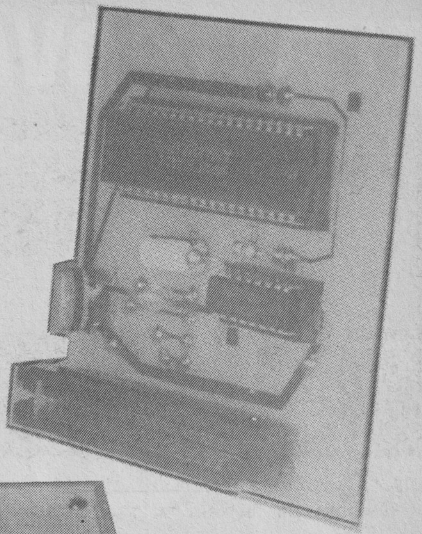
Electronics manufacturers throughout Europe are receiving a series of unusual sales leaflets from a manufacturer of specialist chemicals used in the making of printed circuit boards.

Dynachem are sending out four leaflets spaced at regular intervals. On the front of each will be printed a tantalising part of the company's DYNAGIRL, an exquisite young lady well worth a second look. By keeping the leaflets, the recipient will be able to build up a complete picture.

On the reverse sides will be information about the company's range of photo-resists, plating solutions, brighteners, cleaners and ancillary chemicals.

ZX81 HARDWARE

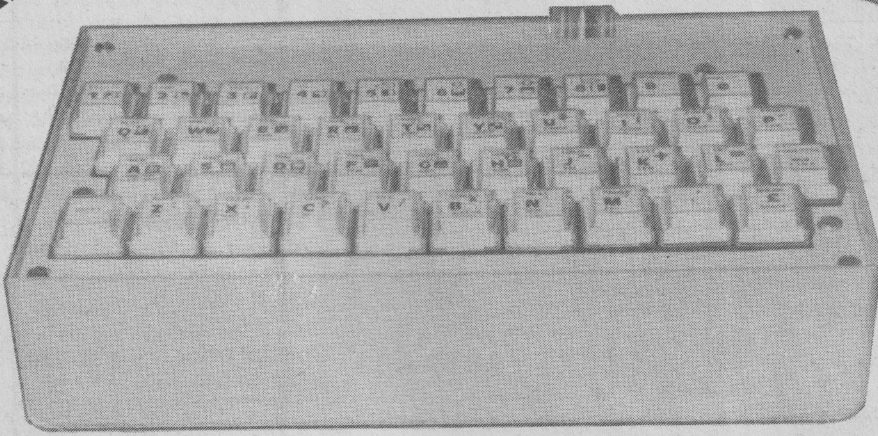
- KEYBOARD KIT 20.75
- BUILT 25.50
- CASE 10.30
- BUILT & FITTED IN CASE 36.15

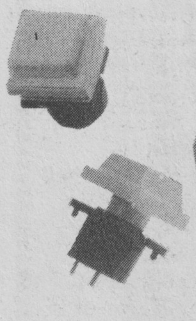


IN/OUT PORT
- KIT 16.95
- BUILT 18.95

24 lines, in or out.
Programmed by BASIC.

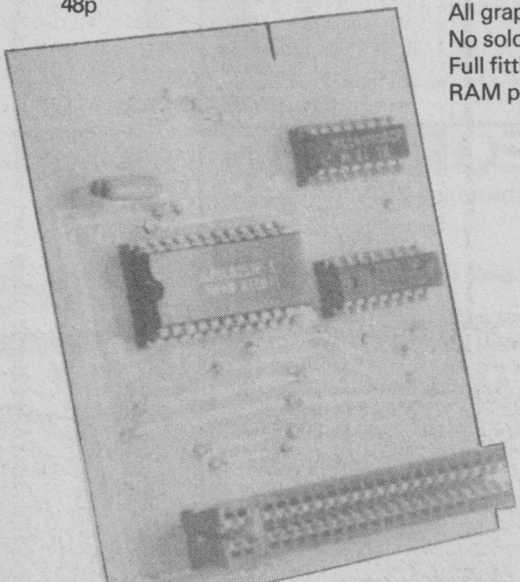
EX STOCK!



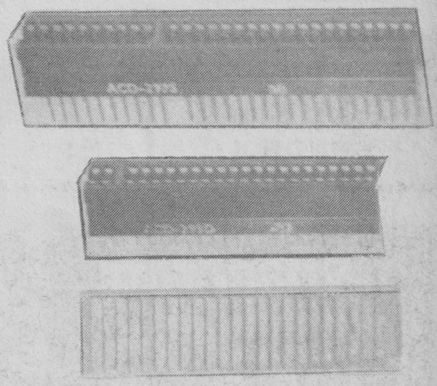


Spare switch
48p

40 typewriter keys.
All graphics etc shown.
No soldering (built version) just plug in.
Full fitting and assembly instructions supplied.
RAM pack operation not effected.



CASE
Ready punched top.
All screws supplied.
Feet supplied.
(For keyboard only, ZX81 does not fit inside).



CONNECTORS
- ZX81 23 WAY 2.95
- MALE CONN 1.30
- IN-OUT/MUSIC BD 3.00
- 24 WAY RIBBON CABLE 1.40
- RAM PACK CONN 6.95

(Allows RAM pack to be mounted away from ZX81).

MUSIC BOARD
- KIT 16.95
- BUILT 18.95

3 outputs.
.01Hz to 2Mhz.
Programme by BASIC.

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REDDITCH
WORCESTERSHIRE
B97 4RU

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BOXES

VERO
ALUMINIUM
BIMBOX

DESCRIPTION		L	W	D	PRICE
VERO INSTRUMENT CASES	21034	205	140	40	426p
	21035	205	140	75	474p
	21036	205	140	110	617p
	21037	180	120	39	388p
	21038	180	120	65	416p
	21039	180	120	90	443p
	21040	155	85	39	312p
	21041	155	85	60	341p
	21042	156	86	80	407p
	21047	125	65	30	222p
	21048	125	65	39	282p
	21049	125	65	50	318p
VEROPLASTIC General purpose					
	(black) 21024	72	47	25	50p
	(white) 21025	72	47	25	50p
	21390	120	80	35	78p
	21391	180	110	55	145p
ALUMINIUM Pressed, with two 4PK screws					
	B7	70	133	38	85p
	AB8	101	101	38	85p
	AB9	101	70	38	85p
	ab10	101	133	38	85p
	AB11	101	64	51	85p
	AB12	76	51	25	85p
	AB13	152	101	51	67p
	AB14/2	127	89	64	99p
BIMBOXES Plastic ABS	20002	100	50	25	87p
	2004	121	66	40	106p
	2005	152	82	50	123p
	2006	192	113	61	216p
Plain Diecast					
	5001P	50	50	25	88p
	5002P	100	50	25	110p
	5003P	113	63	31	130p
	5004P	121	66	40	150p
	5005P	152	82	50	195p
	5006P	192	113	61	305p
Grey painted Diecast					
	5001	50	50	25	116p
	5002	100	50	25	145p
	5003	113	63	31	190p
	5004	121	66	40	145p
	5005	152	82	50	322p
	5006	192	113	61	425p

HANDY PACKS *Save you time, trouble and money*

RESISTORS
Each pack contains 100 in one decade quantities of each value according to popularity — ideal for general stock.
RD1 (1-8.2Ω) RD2 (10-82Ω) RD3 (100-820Ω) RD4 (1K-8K2) RD5 (10K-82K) RD6 (100K-820K) RD7 (1M-10M) **Price £1.50 each**
CAPACITORS Type CP1 **Price £4.20**
Contains 100 ceramic capacitors, most values 1.8pF to 0.1μF, quantities of each according to popularity.

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Types 5F2, 5F, 18F2, 18F, 224F, 266F	**14p each**
2Y-T066	**£1.23**
2Y-T03	**96p**
TV3	**29p**
TV35 10DN	**£1.98**
6W4 (Drilled)	**£4.30**

Many other types and sizes in stock

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741C8	**18p**
748C8	**35p**
7555	**86p**
CA3080E	**86p**
CA3130E	**99p**
CA3140E	**55p**
LM380N	**99p**
LM381	**£1.51**
LM3914N	**£2.68**
NE555V	**23p**
NE556A	**76p**
TDA2030	**£1.45**
TL071CP	**45p**
TL072CP	**75p**
TL074CN	**£1.20**
UAA170	**£1.52**
XR2206	**£4.60**
ZN414	**£1.22**
ZN425E	**£3.90**

SWITCHES *A selection of popular best-sellers from our great assortment of different types*

MINIATURE TOGGLE
250V AC/2A Chrome dolly
Made in U.S.A.

S7101 Single throw/Double pole	57p
S7103 SP DT/Centre OFF	71p
S7201 DP/DT	96p
S7211 Single Pole/Three way	140p
S7301 Three pole/DT	160p

DUAL IN LINE (D.I.L.)

Single Throw		Changeover	
Single Pole	54p	Single Pole	81p
4 Pole	95p		50p
6 Pole	136p		210p
8 pole	187p		252p
10 pole	210p		305p

With British gold-plated contacts

ROTARY TYPE
One pole/12 way: Two pole/6 way: Three pole/4 way: Four pole/3 way all **40p each**

MAINS SWITCHES
Double pole double throw, slider or standard

Standard	20p
Slider	20p
Min	18p

CONNECTORS

We stock connectors from highly specialised types to the everyday kind that you must be sure of being able to get when you want them. Here are some examples. See also Catalogue 82.

AUDIO DIN

Ways	Plug	Socket
2	8p	8p
3	14p	8p
4	15p	14p
5(180°C)	14p	
6	18p	20p
7	19p	19p

D-TYPE

Ways	Sock	Plug	
9	104p	78p	130p
15	147p	106p	139p
25	218p	150p	152p
37	315p	210p	160p

PANEL MOUNTING METERS

SPECIAL OFFER TO MARCH 31st

Panel mounting meters offered in the following F.S.D. ranges:—
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FREQUENCY METERS

Model 8000B: 9-digit 1GHz Frequency Meter.

Professional specification:	**£160.00**
2015A Bench DMM (LCD)	**£83.00**
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5020A 1.200KHz Function Generator, Sine, Squarer, Triangle and separate TTL Square wave outputs	**£79.00**

S.a.E. brings full details

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BUDGET RANGE All primaries 240V

SECONDARIES	5VA	15VA	24VA
0-6, 0-6	£2.85	£3.40	£4.40
0-12, 0-12	£2.85	£3.40	£4.40
0-15, 0-15	£2.85	£3.40	£4.40
0-20, 0-20	£2.85	£3.40	£4.40

CHARGER TYPES Secondaries

0-9-17V 1A	**£3.15**
0-9-17V 2A	**£3.70**
0-9-17V 4A	**£4.70**

(giving about 14V on full load)

TOROIDAL RANGE

For details of secondary outputs, please see current I.L.P. Advertisements
All primaries — 240 Volts
30VA — £5.25: 50VA — £6.40: 80VA — £6.80: 120VA — £7.75 160VA — £10.10: 225VA — £11.65; 300VA — £13.50: 500VA — £17.25
Remember — C.W.O. Orders (UK) are sent post paid if value £6.00 or over

QUICK REF TTL I.C. SELECTION

7400	.15
7401	.15
7402	.15
7403	.16
7404	.18
7405	.15
7406	.25
7407	.24
7408	.21
7409	.18
7410	.15
7413	.25
7414	.63
7420	.15
7430	.15
7440	.13
7442	.45
7443	.60
7444	.60
7447	.73
7448	.67
7450	.13
7451	.13
7453	.13
7454	.13
7460	.13
7470	.24
7472	.26
7473	.26
7474	.23
7475	.42
7476	.30
7480	.35
7482	.74
7483	.52
7485	.74
7486	.26
7489	1.59
7490	.28
7491	.71
7492	.43
7493	.40
7494	.55
7495	.54
7496	.54
74100	.85
74104	.42
74107	.27
74121	.27
74123	.47
74125	.45
74126	.43
74141	.54
74151	.43
74154	.75
74155	.46
74156	.46
74157	.48
74190	.70
74192	.70
74193	.70
74393	.95
74LS00	.14
74LS02	.14
74LS04	.16
74LS05	.23
74LS08	.20
74LS10	.19
74LS11	.20
74LS14	.58
74LS20	.18
74LS30	.21
74LS323	.22
74LS37	.24
74LS38	.35
74LS42	.59
74LS47	.89
74LS51	.25
74LS73	.30
74LS74	.30
74LS75	.44
74LS76	.30
74LS85	.80
74LS86	.38
74LS90	.44
74LS92	.59
74LS93	.57
74LS107	.40
74LS112	.38
74LS123	.82
74LS125	.45
74LS126	.42
74LS132	.60
74LS136	.42
74LS137	1.10
74LS138	.45
74LS139	.70
74LS145	1.20
74LS148	1.65
74LS151	.77
74LS153	.77
74LS155	.94
74LS156	.94
74LS157	.60
74LS161	.78
74LS163	.90
74LS169	.90
74LS165	.75
74ls166	1.65
74LS173	1.00
74LS174	.85
74LS175	.94

More still in Cat 82 as well as semi conductors in great variety

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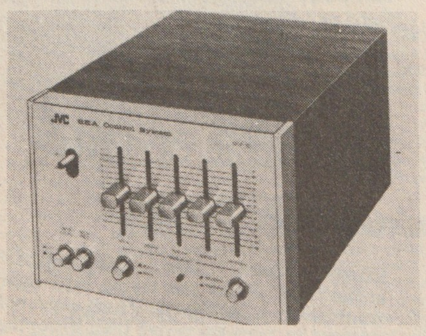
ETI NEWS SEPT 1981

Mini Discs

Philips, Sony and PolyGram have declared the Compact Disc Digital Audio System ripe for production. These companies are unanimous in the belief that this new system will eventually replace the LP as we know it. PolyGram Records Operations and CBS/Sony have now put their productions on Compact Disc. It is not expected that the CD will be on the market before the autumn of next year.

STEREO CONTROL UNIT

Connect this unit to your existing power amplifier, and at your fingertips you will have a degree of control over the audio spectrum previously unattainable with conventional tone control systems. JVC's unique Model SEA-10 takes the full audio range of 20 to 20,000Hz and divides it up into five discrete frequency bands centred at 40, 250, 1000, 5000, and 15,000Hz. Each band can then be varied independently by ± 12dB using the professional type slider controls with 2dB click stops.



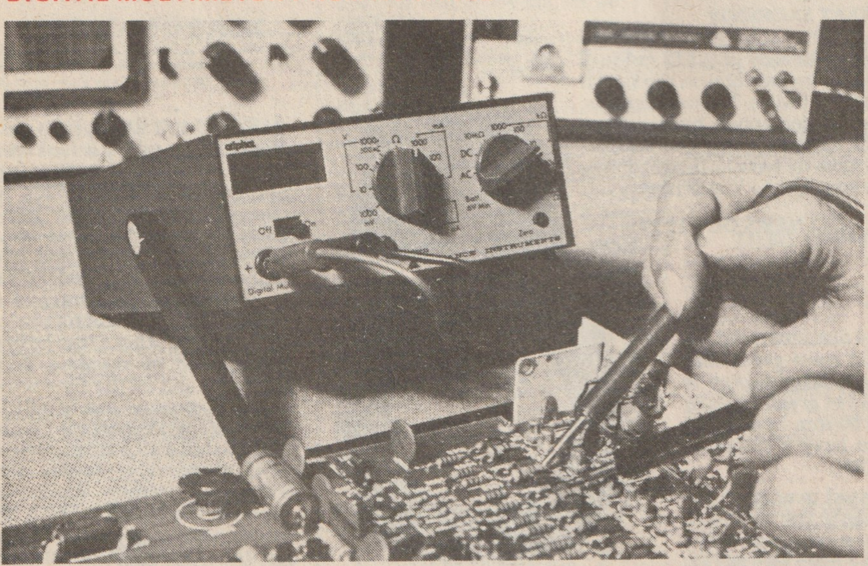
ETI NEWS JULY 1973

ETI NEWS MAY 1975

CARTRIDGE PERCUSSION UNIT

Bandmaster Limited of Gloucester Street, Glasgow, have designed a rhythm unit called the Powerhouse which uses multi-track continuous tape loop to produce multi bar synchronised "live" percussion rhythms.

DIGITAL MULTIMETER FROM ADVANCE



The way things are going, the adjective 'digital' will soon be dropped when talking about test gear. The advantages of digital readout are overwhelming compared to the standard meter (which has of course an analogue readout) and most new quality test equipment utilises direct digital readout.

One of the recently introduced DMM's is the Alpha from Advance Electronics; amongst the many attractive features is the price of £55.

ETI NEWS JUNE 1973

MPG meter.......

A device called a Mileage Computer (what else?) from the Young Corporation in America is designed to produce a digital readout of miles per gallon being obtained from a vehicle at any given instant.

The device is composed of speed and distance sensors, fuel level indicator and calculator circuit. A sensor attached to the speedo picks up pulses every revolution to provide some of the info needed.

The MPG meter will sell at around $20 in the USA. ETI NEWS DEC 1977

COLOUR PREJUDICE?

Official figures for the number of homes with colour TV's, i.e. those with a license, have just exceeded 50% of the total. Some lesser mortals might well be tempted to conjecture how high the total would be if the un-licensed felons in our midst could be stood up and counted. Naturally we refrain from any such thoughts.

ETI NEWS DEC 1976

TELEPHONE COMPONENTS

High-standard telephony today relies on components and function elements whose design and properties render them equally suitable for use in completely different fields. Read-only memories, MT components, keylock connectors and automatic cutouts are some examples of such components.

The MT (magnetic-core transistor) component developed detection of switching criteria in dc signalling systems, has a magnetic core with a rectangular hysteresis loop to detect signals which are amplified by the transistor. The core and transistor circuits are operated at the same potential and the defined Yes/No statements can be evaluated electronically or via relay circuits.

ETI NEWS APRIL 1973

CMOS IN PLASTIC PACKAGES

Motorola Semiconductors have just announced that 39 devices from their standard CMOS logic family are now available in plastic packages. In the past, ceramic packages have been used for all CMOS devices

ETI NEWS SEPT 1973

FAIRCHILD TO MAKE CONSUMER PRODUCTS

The USA's Fairchild group are actively planning to enter the consumer products market, according to a usually reliable source.

Fairchild's first products are believed to be a low-end of the market one-chip hand-held calculator with 8-12 digits. However several industry commentors query Fairchild's ability to produce the necessary MOS chips, quoting Lester Hogan's (president of Fairchild) own description of his company's performance in the MOS field as 'disappointing'.

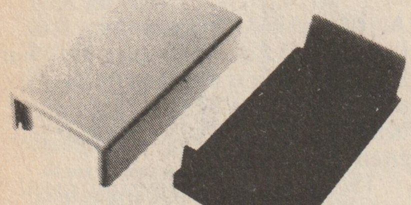
ETI NEWS JUNE 1974

PLASTIC BOXES

Vero Electronics Limited have recently become distributors for the Odenwalder Kunststoffwerk range of plastic products which include a range of plastic boxes. These are manufactured from high impact polystyrene, which is suitable for machining, engraving and silk screen printing. The upper portion of the box is coloured light grey and the lower portion, dark grey. The latter is provided with integral fixing points for circuit boards. The boxes can be free standing or wall mounting and should provide an attractive enclosure for reader's projects.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants.

ETI NEWS JAN 1974



SOVIET RADAR BLAMED FOR HIGH HEART DISEASE

A Russian radar tracking station near the Finnish town of Ilomaritsi may be responsible for a sharp increase in heart disease and cancer according to Dr. Milton Zaret, an American microwave expert.

The Finnish border towns have the highest rate of heart disease in the world and cancer has increased inexplicably.

ETI NEWS JULY 1975

the little cb that santa forgot

Citizen Band radio manufacturers around the world are crying into their transceivers after Xmas. They expected a boost to sales to revive their drooping business, and it didn't materialise. Seems no-one wanted to contact anyone else – not even the reindeer.

ETI NEWS MARCH 1978

BLUE RESEARCH

Your choice of LED colours might include blue in the not so distant future. The new devices, being developed by Siemens, use silicon carbide and are predicted to have a forward voltage drop of 4 V at 50 mA.

ETI NEWS OCT 1979

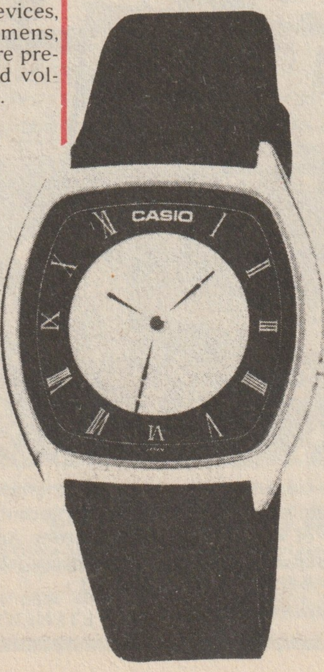
* Polaroid are about to release an automatic focusing camera that uses an ultra-sonic transducer to measure distance.

* Computers stores in the US are opening up literally every day — we have just heard that 700 have been identified by someone preparing an exhibition! In addition to those dedicated to Home computers, office equipment suppliers and camera shops are at the forefront when it comes to jumping on the bandwagon; even Macey's stores have now got a computer department in some of their stores.

* Sanyo have demonstrated a 6 mm thin solid state green and black television. The display is made out of 6,144 green LEDs in an area only 50 mm by 75 mm. They hope to have a commercial set by 1981.

* A radar based overspeed detector is in use in the U.S. of A, the unit measures your speed and lights up a neon sign saying YOUR SPEED IS . . . . REDUCE SPEED. The unit is very effective, only problem was the local hot-rodders using it to check their top speed! Problem solved by limiting display to 75 instead of 99.

ETI NEWS SEPT 1978



Watch This!

If you're sick of digital watches, how about taking a look at this watch from Casio. Its all analogue, but with a difference. It's fully electronic and has no moving parts. It uses LCD and has conventional hours, minutes and sweep seconds hands. The Model AN8GL is designed to be attractive and fashionable, face colour matches the synthetic strap. Hour positions are marked by standard Roman numerals and all the time settings and adjustments are handled by two buttons, keeping the compact gold-plated watch case simple and uncluttered. The display shows hour and minute hands, and seconds indication is by a third sweep hand or as a series of marks on the face edge to show accumulated seconds. Accuracy is to within 15 seconds a month. RRP is £27.95, but products of this type are often sold cheaper. Further information can be obtained from Casio Electronics Co Ltd, 28 Scrutton Street, London EC2A 4TY.

ETI NEWS NOV 1981

GREENWELD

443A Millbrook Road Southampton SO1 OHX

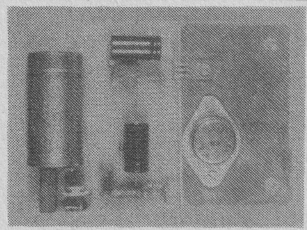
All prices include VAT at 15% — just add 50p post

CONGRATULATIONS TO ETI ON THEIR 10TH ANNIVERSARY

Here are some special Bargains to celebrate!!!

ET1 Electrolytic Pack — 10 each of these PC mntg types: (uF/V) .47/50, 1/50, 2.2/50, 4.7/40, 10/40, 22/50, 33/25, 47/16, 47/40, 100/16, 100/35, 220/63, 330/25, 1000/16. Total 150 caps for **£6.95**
ET2 1A rects — 25 each 1N4001, 3, 5 & 7. Total 100 for **£3.95**
ET3 Minibox polyester caps — 10 each of .01/630, .022/250, .047/400, .068/250, .1/100, .22/100, .33/100, 47/100, 1/100. Total 90 caps for **£3.50**
ET4 TTL pack — 5 each of: 7400, 02, 05, 10, 13, 20, 30, 47, 73, 74, 86, 90, 93, 96, 107, 121. Total 80 chips for **£14.95**
ET5 100V 12A stud mntg diodes — 10 for **£2**
ET6 2¼in 8R speakers — 2 for **£1**
ET7 200V 4A Triacs — 6 for **£1**
ET8 1500uF 40V PC mntg caps. 5 for **£1**
ET9 750uF 16V axial caps — 12 for **£1**
ET10 ½W 5% CF resistors, 20 each of these values: 2R2, 4R7, 6R8, 22R, 33R, 47R, 68R, 150R, 270R, 560R, 820R, 1k2, 1k5, 2k2, 3k3, 12k, 68k, 82k, 120k, 180k, 750k, 3M9, 5M6, 6M8, 10M. Total 500 for just **£3.50**
ET11 Mains transformer, 12—0—12V 50mA. 2 for just **£1**
ET12 100 1N4148 diodes **£2**

STABILIZED PSU PANEL



A199 A versatile stabilized power supply with both voltage (0—30V) and current (20mA—2A) fully variable. Many uses inc bench PSU, Nicad charger, gen. purpose testing. Panel ready built, tested and calibrated. **£7.75.** Suitable transformer and pots **£6.00.** Full data supplied.

SPECIAL ETI BIRTHDAY OFFER (Aren't we nice!!!!)

The above PSU, transformer, pots, heatsink, 0—30V and 0—2A meters, switch, terminals, neon and smart cabinet to mount it all in, plus wiring diagram & info.

JUST £24.95

MIXED LED PACK

All new full spec by Micro, Fairchild, etc. Red, Yellow, Green, Amber, Clear, 3mm & 5mm. Pack of 50 asstd **£3.95; 250 £15**

1W AMP PANELS

A011 Compact audio amp intended for record player on panel 95 × 65mm including vol control and switch, complete with knobs. Apart from amp circuitry built around LM380N or TBA820M, there is a speed control circuit using 5 transistors. 9V operation, connexion data supplied. **ONLY £1.50.**

OP—AMP PSU KIT

A198 All parts + instructions to make a 50mA + 15, 0, —15V supply from mains input. Only **£1.95**

P.C. ETCHING KIT MkV

The best value in etching kits on the market — contains 100 sq ins copper clad board, Ferric Chloride, Etch resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. All for **£4.95.**

PANELS

Z521 Panel with 16236 (2N3442) on small heat sink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. **60p.**
Z527 Reed relay panel — contains 2 × 6V reeds, 6 × 2S030 or 2S230, 6 × 400V rects + Rs. **50p.**
Z529 Pack of ex-computer panels containing 74 series ICs. Lots of different gates and complex logic. All ICs are marked with type no. or code for which an identification sheet is supplied. 20 ICs **£1.00**; 100 ICs **£4.00**
A504 Black case 50 × 50 × 78mm with octal base. PCB inside has 24V reed relay, 200V 7A SCR, 4 × 5A 200V rects, etc. **60p.**

CHEAP CHIPS

76477 Sound IC **£1.25**
2102A RAM 8 for **£3**
MK4027 shift reg. 8 for **£6**
uA78MG + volt reg **£1.00**
uA79MG — volt reg **£1.20**
74LS112 Dual Flip-Flop 8 for **£1**
TIL311 Hexadecimal display with decode 0—9 and A—F. With data **£3.50.**

DEVELOPMENT PACKS

These packs of brand new top quality components are designed to give the constructor a complete range so the right value is to hand whenever required. They also give a substantial saving over buying individual parts.
K001 50V ceramic plate capacitors, 5%, 10 of each value 22pF to 1,000pF, total 210 **£4.80.**
K002 Extended range 22pF to 0.1. Values over 1000pF are of a greater tolerance. 10 of each value 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1000, 1500, 2200, 3300, 4700, 6800, 01, 015, 022, 033, 047, 1 **PRICE £7.66**
K003 C280 or similar Polyester capacitors, 10 each of the following: .01, .015, .022, .033, .047, .068, .1, .15, .22, .33 and .47uF **PRICE £5.40**
K004 Mylar capacitors. Small size, vertical mounting 100V. 10 each of the following: .001, .0012, .0015, .0018, .0022, .0027, .0033, .0039, .0047, .0056, .0068, .0082, .01. Total 130 capacitors **PRICE £4.70**
K007 Electrolytic capacitors 25V working small physical size axial or radial leads. 10 each of the following: 1, 2.2, 4.7, 10, 22, 47, 100uF. Total 70 capacitors. **PRICE £3.59**
K008 Extended range, as above, also including 220, 470 and 1000uF all at 25V. Total of 100 capacitors. **PRICE £6.35**
K021 CR25 resistors or similar, miniature ¼ watt carbon film 5%, as used in nearly all projects. 10 of each value from 10 ohms to 1M. E12 series. Total 610 resistors. **PRICE £5.95**
K041 Zener diodes 400mW 5%. 10 each of all the values from 2V7 to 36V. Total 280 zeners. **PRICE £15.95**
K051 LEDs. Pack of 60 comprising 10 each red, green and yellow 3mm and 5mm together with clips. **PRICE £8.95**

UHF TUNERS

GJE Sylvania F4720 Channels 21—69. Brand new, no data **£3.00.**

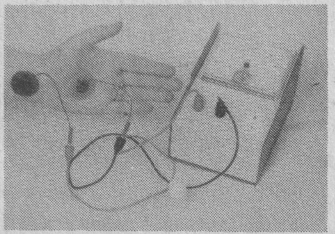
VHF TUNERS

Type F3720 (CCIR) by Sylvania. Bargain at only **£3.00.**

RELAY/TRIAC PANEL MKII

Z537A PCB 100 × 75mm containing a wealth of components: 2 × 12V DPCO min relays, SC146E 10A 400V triac, 555 timer, 10 × 1N4001 diodes, 2N5061 SCR, 2 × 3mm LED's 3 × 2N3704, R's & C's — Amazing value — if bought separately, parts would cost around £8!! Our price for the panel, just **£1.50**

LIE DETECTOR



Not a toy, this precision instrument was originally part of an "Open University" course, used to measure a change in emotional balance, or as a lie detector. Full details of how to use it are given, and a circuit diagram. Supplied complete with probes, leads and conductive jelly. Needs 2 4½V batts. Overall size 155 × 100 × 100mm. **Only £7.95** — worth that for the case and meter alone!!

1000 RESISTORS £2.50

We've just purchased another 5 million preformed resistors, and can make a similar offer to that made two years ago, **at the same price!!!** K523 — 1000 mixed ¼ and ½W 5% carbon film resistors, preformed for PCB mntg. Enormous range of preferred values. **1000 for £2.50; 5000 £10; 20k £36**

200 ELECTROLYTICS £4.00

K524 Large variety of values/voltages, mostly cropped leads for PCB mntg. 1—1000uF, 10—63V. All new full spec components, not chuck-outs!! 200 **£4**; 1000 **£17.50**

CAPACITOR BARGAINS

2200uF 100V cans 80 × 40mm dia **75p**; 10/**£5.50**; 220uF 10V axial **5p**; 100 **£2.30**; 1000 **£16**; 400 + 100uF 275V 102 × 44mm dia. **75p**; 10 **£5.50**; 200uF 350V, 100 + 100 + 50uF 300V can 75 × 44mm dia. **40p**; 10/**£3**; 100/**£20**; 100uF 25V Axial **£3**/100.
0.33uF 50V rad. **£1.50**/100, **£12**/1000
0.47uF 50V rad. **£1.50**/100, **£12**/1000 elec
22uF 50V rad **£3**/100, **£24**/1000
Electrolytics: 10u40V PC mntg 25/**£1.25** 100/**£3**; 4.7u/63V PC mntg **same price**
1250u/25V can 10/**£1.60** 100/**£10**
1500u/40V can 10/**2.20** 100/**£15**
800u/250V can 10/**£5.50** 100/**£44**
400u/400V can 10/**£8** 100/**£56**
100u/350V, 100 + 100 + 50/300V (all in one can) 10/**£5.00** 100/**£36.00**

TOROIDAL TRANSFORMER

110mm dia × 40mm deep. 110/240V pri., Sec 18V 4A, 6.3V 1A, 240V 0.3A. Ideal for scopes, monitors, VDU's etc. Special low price **£5.95**

TRANSFORMERS

Mains primary, 50V 20A sec. **£20.00**
Mains pri. 110V 15A sec **£30**; 20A **£40.00**

DISC CERAMICS

0.22uF 12V 9mm dia. Ideal for decoupling. 100 for **£2.75**; 1000 **£20.00**
0.05uF 12V 15mm dia. 100 **£1.50**; 1000 **£12.00**
Pack of disc ceramics, assorted values and voltages — 200 for **£1.00**

1N4006 DIODES

Special purchase of 1A rects, Russian made. Packed in boxes of 300, **£8.50** per box; 4 boxes **£30.00**; 10 boxes **£75**

AUDIBLE WARNING DEVICE

Solid state circuit drives high efficiency transducer to give high output. Voltage reqd 6—18V. Can also be driven direct from TTL or CMOS. Module size 45 × 21 × 12mm. Comprehensive data supplied **£150**

NICAD CHARGER

Versatile unit for charging AA, C, D and PP3 batteries. Charge/test switch, LED indicators at each of the 5 charging points. Mains powered. 210 × 100 × 50mm. **£7.95**

ULTRASONIC ALARM — £14.95

Originally made to retail at over £50, these neat units housed in a 120 × 100 × 45mm case are brand new and boxed. They work by transmission of a 40kHz beam which responds to movement by detecting the Doppler freq. shift. Mains operated with internal buzzer and provided with data, these units are excellent value at only **£14.95**

SOLENOIDS AND RELAYS

W921 Solenoid rated 48V at 25% duty cycle, but work well on 24V (700gm pull, 10mm travel) push or pull 27 × 18 × 15mm **55p**
W922 Mains 240V ac solenoid, 10% duty cycle, push or pull, 16mm travel. 50 × 20 × 16mm. Only **£1.50**
W895 9V DC relay 500R SPCO 28 × 24 × 19. **50p**
W733 11 pin plug in relay, 240V ac, 3PCO 5A contacts **£2.50.** Base **£36p**
W838 700R 24V 4PCO "continental" relay 35 × 30 × 18, only **84p**; 10/**£7.00**
W847 37R 5—10V relay, SP 3A contact, PCB mntg 11 × 33 × 20. **95p**; 10/**£7.50**
W893 Omron LY4 mains relay, 4PCO 5A contacts. **£2.50**
W896 24V ac coil, but works well on 6V DC. 2 × 10A c/o contacts. Ex-equip, only **60p**

AMAZING! COMPUTER GAMES PCB's for PEANUTS!!

A bulk purchase of PCB's from several well known computer games including Battleships, Simon, Logic 5 and Starbird enable us to offer these at incredibly low prices:

'STARBIRD'

Gives realistic engine sounds and flashing laser blasts — accelerating engine noise when module is pointed up, decelerating engine noise when pointed down. Press contact to see flash and hear blast of lasers shooting. PCB tested and working complete with speaker and batt. clip (needs PP3). PCB size 130 × 60mm. Only **£2.95**

'SIMON'

The object of this game is to repeat correctly a longer and longer sequence of signals in 3 different games. (Instructions included). PCB contains chips, switches, lampholders and lamps, and is tested working, complete with speaker. Needs PP3 and 2 × HP11. PCB size 130 × 130mm. Only **£3.95**

'COMPUTER BATTLESHIPS'

Probably one of the most popular electronic games on the market. Unfortunately the design makes it impractical to test the PCB as a working model, although it may well function perfectly. Instead we have tested the sound chip, and sell the board for its component value: SN76477 sound IC; TMS1000 u-processor; bat clips, R's, C's etc. Size 160 × 140mm. **Only £1.50.** Instruction book and circuit **30p** extra

'MICROVISION' Cartridges

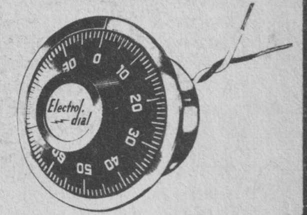
These are a small PCB with a micro-processor chip, designed to plug in to the microvision console. Only snag is we don't have any consoles!! However, they can be used as an oscillator with 4 different freq. outputs simply by connecting a battery and speaker. Tested and working (as an osc) with pin out data. PCB size 72 × 60mm.

ONLY 25p each!!

LOGIC 5 PANEL

Tested Logic 5 now sold out — but we have some PCB's with 10 LED's and chip on, but no keyboard. Not tested. **50p**

ELECTRO-DIAL



Electrical combination lock — for maximum security — pick proof. 1 million combinations!! Dial is turned to the right to one number, left to a second number, then right again to a third number. Only when this has been completed in the correct sequence will the electrical contacts close. These can be used to operate a relay or solenoid. Overall dia. 65mm × 60mm deep. Only **£9.95**
Also availabe without combination — Only **£3.95**

1982 CATALOGUE

. . . is not ready yet!!! 1981 edition is now out of print, but the big new 1982/3 edition should be ready by late March '82 — **Send 75p for your copy now!!**

WHOLESALE LIST

We have in stock many millions of components — we supply shops, M/O companies, Schools, Industrial Users etc. Can we supply you, too? Our quantity (100+) prices for new full-spec components is very competitive. Ask for our free bulk-buyers list.

NEW CONTROL SYSTEM FOR SLR CAMERAS

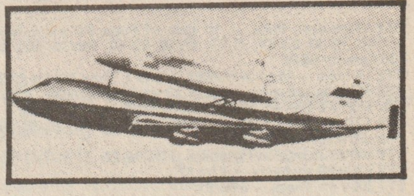
Electronic shutter speed and exposure controls can now be built into single lens reflex cameras without mechanically modifying the camera bodies or lenses.

A new control system, developed by Matsushita Electrical Industrial Corporation, measures the light at a preset aperture (in less than two milliseconds) and then sets exposure time accordingly. Control range varies from 0.0005 seconds to four seconds — dependent upon lens aperture and film speed.

Prior to the Matsushita development, it was necessary to have a light measuring device accommodated behind the main lens — calculating light intensity with the lens held wide open. ETI NEWS JULY 1975

RIDING HIGH

The next step in America's space programme is the tesing of NASA's space shuttle. Landing tests are to be carried out in mid 1977. Amazingly the machine will be launched 'piggy-back' from a Jumbo 747! Several



flights will be made to ensure stability before the shuttle is actually released. Trust Americans to build the worlds largest airliner and then carry people *outside* it! ETI NEWS AUG 1976

Elrad: ETI Germany...............

A new edition of ETI starts this month — Elrad in Germany. The name Elrad itself means nothing and is simply an amalgamation of electronics and radio. It is being published by Heinz Heise in Hanover and is edited by Udo Wittig ETI NEWS JAN 1978

COSMOS NOW CHEAPER THAN TTL FOR MAJORITY OF DIGITAL SYSTEMS

RCA has announced further price reductions in its CD4000 range of COS/MOS integrated circuits. The reductions range from 35% to 50%. The biggest price reductions have affected the more established MSI devices of the CD4000 range, with many types being reduced by over 50%.

As a result of the price cuts, many of the popular TTL devices are currently more expensive than the equivalent COS/MOS functions.

ETI NEWS SEPT 1975

CB2B

At long last a specification has been published by the Home Office for the legalisation of Citizen's Band radio. Two frequencies will be allocated: 934.025 to 934.975 MHz and 27.60125 to 27.99125 MHz. For the 934 MHz (AM) frequencies the maximum power is 8 W (25 W ERP), 20 channels at 50 kHz channel spacing. Hand-held units are restricted to 3 W PEP. On the 27 MHz (FM) frequencies the maximum power is 4 W (2 W ERP), 40 channels at 10 kHz spacing. Frequency tolerance: ±1.5 kHz. Maximum frequency deviation: ±2.5 kHz. Adjacent channel power: −60 dB to 2 uW, spurious emission less than 50 nW.

ETI NEWS JULY 1981

CBM AGAIN!

Right — now you've stopped staring at the picture can we proceed with this month's news. Thank you. Once again our old friends CBM have managed to get in on the act. The above watches — yes **watches** — represent their long-awaited entry into the digital watch market — with the 5,000 series. All three use a common module, with the casings making for a price range of £17.50-£21.00.

ETI NEWS JAN 1977

PLAY-ALONG-WITH-RCA

Single chip I/O for video games is the laudible aim of messers. RCA. To be introduced in January the device is primarily a vertical and horizontal synching circuit designed for use with RCA's 1802 MPU. Price could well be around £12 when and if introduced into this country.

ETI NEWS DEC 1976

TTLs

7400	11p
7401	11p
7402	12p
7403	12p
7404	12p
7405	18p
7406	25p
7407	25p
7408	14p
7409	15p
7410	15p
7411	20p
7412	20p
7413	22p
7414	35p
7416	25p
7417	25p
7420	17p
7421	30p
7422	20p
7423	22p
7425	28p
7426	30p
7427	25p
7428	30p
7430	15p
7432	25p
7433	27p
7437	27p
7438	30p
7440	17p
7441	70p
7442A	36p
7443	90p
7445	60p
7446A	93p
7448	45p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	30p
7474	20p
7475	30p
7476	30p
7480	50p
7481	100p
7482	70p
7483A	45p
7484	100p
7485	90p
7486	20p
7489	210p
7490A	25p
7491	60p
7492A	30p
7493A	30p
7494	50p
7495A	50p
7496	45p
7497	120p
74100	85p
74107	22p
74109	40p
74116	90p
74118	75p
74119	90p
74120	70p
74121	25p
74122	45p
74123	48p
74125	40p
74126	40p
74128	40p
74132	45p
74136	32p
74141	65p
74142	200p
74145	70p
74147	100p
74148	75p
74150	80p
74151A	45p
74153	45p
74154	70p
74155	50p
74156	50p
74157	50p
74159	100p
74160	60p
74161	60p
74162	60p
74163	60p
74164	50p
74165	55p
74166	70p
74170	140p
74172	300p
74173	65p
74174	60p
74175	60p
74176	50p
74177	70p
74178	100p
74180	50p
74181	160p
74182	90p
74184A	90p
74185	120p
74186	500p
74188	325p
74190	50p
74191	50p
74192	50p
74193	50p
74194	70p
74195	60p
74196	70p
74197	60p
74198	100p
74199	100p
74221	60p
74259	70p
74278	150p
74279	80p
74283	75p
74284	200p
74285	200p
74290	100p
74293	100p
74298	100p
74365	55p
74366	55p
74367	55p
74368	55p
74390	100p
74393	100p
74490	120p

74LS SERIES

74LS00	12p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	15p
74LS05	15p
74LS08	16p
74LS09	15p
74LS10	15p
74LS11	15p
74LS13	25p
74LS14	40p
74LS20	15p
74LS21	15p
74LS22	16p
74LS26	16p
74LS27	16p
74LS30	15p
74LS32	16p
74LS37	16p
74LS38	16p
74LS42	36p
74LS47	40p
74LS51	15p
74LS55	30p
74LS73	25p
74LS74	16p
74LS75	24p
74LS76	20p
74LS83	45p
74LS85	65p
74LS86	20p
74LS90	28p
74LS92	40p
74LS93	30p
74LS95	45p
74LA96	100p
74LS107	45p
74LS109	30p
74LS112	34p
74LS113	30p
74LS114	30p
74LS122	42p
74LS123	50p
74LS124	120p
74LS125	30p
74LS126	30p
74LS132	45p
74LS133	30p
74LS136	30p
74LS138	34p
74LS139	36p
74LS145	75p
74LS147	160p
74LS148	90p
74LS151	70p
74LS153	60p
74LS154	90p
74LS155	40p
74LS156	40p
74LS157	35p
74LS158	36p
74LS160	40p
74LS161	40p
74LS162	40p
74LS163	40p
74LS164	48p
74LS165	100p
74LS166	90p
74LS170	120p
74LS173	70p
74LS174	45p
74LS175	50p
74LS181	140p
74LS190	50p
74LS191	50p
74LS192	50p
74LS193	48p
74LS194	40p
74LS195	48p
74LS196	60p
74LS197	65p
74LS221	60p
74LS240	70p
74LS241	70p
74LS242	80p
74LS243	80p
74LS244	65p
74LS245	90p
74LS251	40p
74LS253	40p
74LS257	45p
74LS258	40p
74LS259	90p
74LS260	24p
74LS266	25p
74LS273	70p
74LS279	45p
74LS283	45p
74LS298	160p
74LS323	250p
74LS324	150p
74LS348	150p
74LS352	100p
74LS353	100p
74LS363	160p
74LS364	160p
74LS365	36p
74LS367	36p
74LS268	36p
74LS373	70p
74LS374	70p
74LS375	50p
74LS377	70p
74LS378	60p
74LS390	55p
74LS393	50p
74LS399	200p
74LS540	135p
74LS541	135p
74LS670	170p

4000 SERIES

4000	12p
4001	14p
4002	15p
4006	65p
4007	16p
4008	60p
4009	35p
4010	40p
4011	14p
4012	16p
4013	35p
4014	60p
4015	60p
4016	30p
4017	45p
4018	60p
4019	32p
4020	60p
4021	65p
4022	70p
4023	20p
4024	40p
4025	20p
4026	130p
4027	32p
4028	60p
4029	75p
4030	40p
4031	170p
4034	160p
4035	80p
4036	295p
4039	295p
4040	55p
4041	70p
4042	55p
4043	60p
4044	70p
4046	70p
4047	75p
4048	55p
4049	27p
4050	27p
4051	60p
4052	80p
4053	60p
4054	130p
4055	125p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	18p
4069	18p
4070	18p
4071	18p
4072	18p
4073	20p
4075	20p
4076	60p
4081	16p
4082	20p
4086	72p
4089	150p
4093	40p
4094	150p
4095	95p
4096	95p
4097	340p
4098	90p
4099	120p
40085	90p
40097	£120p
40098	120p
40102	180p
40103	180p
40106	45p
40109	100p
40163	100p
40173	120p
40174	90p
40175	100p
40193	120p
40257	160p
4502	70p
4503	50p
4507	40p
4508	200p
4510	65p
4511	50p
4512	65p
4514	150p
4515	150p
4516	75p
4518	45p
4520	70p
4521	150p
4526	75p
4527	90p
4528	75p
4532	90p
4534	500p
4536	300p
4538	120p
4539	110p
4543	100p
4553	290p
4555	50p
4556	60p
4560	180p
4568	300p
4569	180p
4572	30p
4583	90p
4584	45p
4585	100p
14495	400p

74S SERIES

74S00	60p
74S04	60p
74S08	75p
74S32	90p
74S74	90p
74S85	300p
74S86	180p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S163	300p
74S174	250p
74S175	320p
74S194	350p
74S241	400p

LINEAR I.Cs

AN103	200p	MB3712	225p
AY1-0212	600p	MC1310P	150p
AY1-1313	668p	MC1458	40p
AY1-1320	320p	MC1495L	350p
AY1-5050	140p	MC1496	70p
AY3-8910	600p	MC3340P	120p
AY3-8912	650p	MC3401	90p
AY5-1224A	240p	MC3403	120p
AY5-1315	600p	MK50398	750p
AY5-4007D	520p	ML920	800p
CA3028A	120p	MM57160	620p
CA3019	80p	MN6221A	£6
CA3046	70p	NE531	150p
CA3048	225p	NE555	20p
CA3059	300p	NE556	50p
CA3080E	72p	NE564	420p
CA3086	48p	NE565	130p
CA3089	225p	NE566	155p
CA3090AQ	375p	NE567	140p
CA3130E	90p	NE570	425p
CA3140	50p	NE571	425p
CA3160E	100p	NE5534A	150p
CA3161E	190p	PLL02A	500p
CA3162	450p	RC4136	70p
CA3189E	300p	RC4151	200p
CA3240	120p	RC4558	60p
CA3280G	200p	S566B	260p
DAC1408-8	200p	SAD1024A	1250p
HA1366	195p	SFF96364	800p
HA1388	270p	SL490	350p
ICL7106	850p	SN76477	175p
ICL8038	300p	SP8515	750p
ICM7555	80p	TA7120	165p
LC7120	325p	TA7204	195p
LC7130	325p	TA7205	125p
LF347	160p	TA7222	160p
LF351	48p	TA7310	160p
LF353	100p	TBA651	200p
LF356P	95p	TBA800	90p
LF357	120p	TBA810	100p
LM10C	425p	TBA820	90p
LM301A	27p	TBA950	300p
LM310	120p	TCA220	350p
LM318	200p	TCA940	200p
LM319	225p	TDA1004A	300p
LM324	45p	TDA1008	320p
LM335Z	140p	TDA1010	225p
LM339	65p	TDA1022	550p
LM348	75p	TDA1024	120p
LM358P	75p	TDA1034B	250p
LM377	175p	TDA1170	300p
LM380	75p	TDA2002V	325p
LM381AN	180p	TDA2020	320p
LM382	120p	TL071/81	45p
LM386	95p	TL072/82	75p
LM387	120p	TL074	130p
LM389	95p	TL084	110p
LM393	100p	TL094	200p
LM394	350p	TL170	50p
LM709	36p	TL430C	70p
LM710	50p	UAA170	170p
LM711	70p	UA2240	300p
LM733	100p	UDN6118	320p
LM741	18p	UDN6184	320p
LM747	70p	ULN2003	100p
LM748	35p	UPC575	275p
LM2917	200p	UPC592H	200p
LM3302	140p	UPC1156H	275p
LM3900	55p	XR2206	300p
LM3909	95p	ZN414	90p
LM3911	130p	ZN419C	225p
LM3914	210p	ZN423E	150p
LM3915	225p	ZN424E	135p
LM3916	225p	ZN425E	350p
LM13600	125p	ZN427E	625p
M51513L	300p	ZN1034E	200p
M51516L	500p	ZN1040E	700p

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		−ve	
5V 1A	7805	50p	7905	55p
12V 1A	7812	50p	7912	55p
15V 1A	7815	55p	7915	60p
18V 1A	7818	55p	7918	60p
24V 1A	7824	55p	7924	60p
5V 100mA	78L05	30p	79L05	65p
12V 100mA	78L12	30p	79L12	70p
15V 100mA	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K 1A 5V	135p	78HGKC	600p
LM317K	325p	78HO5KC	550p
LM317T 1A Adj	200p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	500p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305AH	250p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL113	90p
ILQ74	240p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	12p
TIL209 Red	11p	TIL222 Gr	15p
TIL211 Gr	16p	TIL228 Yel	22p
TIL212 Ye	18p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18	NSB5881	570p
		TIL311	600p
DISPLAYS		TIL312/3	110
3015F	200p	TIL321/2	130p
DL704	140p	TIL330	140p
DL707 Red	140p	7750/60	200p
FND357	120p	DRIVERS	
FND500	90p	9368	250p
FND507	90p	9370	300p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

* SPECIAL OFFER *

	1-24	25-99
2114L-2	90p	85p
2716	210p	200p
2532	425p	400p
4116-200nS	70p	65p

COMPUTER COMPONENTS

CPUs

1802CE	700p
2650A	£12
6502	450p
6502A	600p
6800	370p
6802	425p
6809	£10
6809E	£15
8035	750p
8039	850p
8080A	350p
8085A	550p
INS8060	£11
TMS9980	£20
Z80	370p
Z80A	450p
Z80B	£16
8088	£19

SUPPORT DEVICES

3242	800p
3245	450p
6522	500p
6532	775p
6821	160p
6551	650p
6821	160p
6845	£10
6847	£10
6850	160p
6852	250p
6875	600p
8154	950p
8155	800p
8205	220p
8212	160p
8216	160p
8224	250p
8226	250p
8228	250p
8243	450p
8250	850p
8251	350p
8253	800p
8255	350p
8257	800p
8259	800p
8279	950p
Z80PIO	300p
Z80APIO	350p
Z80CTC	300p
Z80ACTC	350p
Z80ADART	800p
Z80ADMA	£12
Z80S101	£12

CRT CONTROLLER

COM5037	£18
SF96364	£8
TMS9927	£18
6845	£10
6847	£10
9365	£60

MEMORIES

2101A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	160p
2114-4L	130p
2147	450p
4027-3	300p
4044-45	450p
4116-15	200p
4116-20	200p
4118-3	500p
4118-4	450p
4164-2	650p
5101	300p
6116P-3	650p
6514-45	£3
6810	200p
7489	210p
74S189	325p
74S201	350p
74S289	325p

ROMs/PROMs

74S188	325p
74S287	308p
74S288	226p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

1702A	500p
2708	300p
2716 (+5V)	300p
2564	£25
2516 (+5V)	300p
2532	550p
2732	550p
2716-300nS	500p
2732-300nS	750p

UARTSs

AY-3-1015P	300p
AY-5-1013P	300p
IM6402	450p
TR1602	300p
COM8017	300p

CHARACTER GENERATORS

RO-3-2513UC	750p
RO-3-2513LC	700p
SN74S262AN	£10

INTERFACE ICs

AD558CJ	775p
AD561J	£14
AM25S10	350p
AM26LS31	160p
AM26LS32	190p
DAC80	£20
DM8131	375p
DP8304	450p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC4024	325p
MC4044	325p
MC14411	700p
MC14412	900p
MC4044	325p
MM58174	£12
ULN2003A	100p
ULN2004A	100p
75017	160p
75110	160p
75112	160p
75114	160p
75115	160p
75150P	140p
75154	140p
75182	230p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	70p
8T26	120p
8T28	120p
8T95	120p
8T97	120p
81LS95	90p
81LS96	120p
81LS97	90p
81LS98	120p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

DISC CONTROL

FD1771	£20
FD1791	£30
FD1793	£32
FD1795	£35
FD1797	£37
WD1691	£15
WD2143	550p

CRYSTALS

32.768KHz	180p
100KHz	300p
200KHz	300p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	250p
2.00MHz	250p
2.45760MHz	250p
2.5MHz	250p
3.276MHz	150p
3.5795MHz	100p
3.686MHz	300p
4.00MHz	150p
4.194MHz	200p
4.43MHz	150p
5.00MHz	175p
4.43MHz	150p
5.00MHz	175p
6.0MHz	150p
6.144MHz	250p
7.0MHz	150p
7.168MHz	175p
8.00MHz	175p
8.86MHz	175p
10.00MHz	250p
10.7MHz	150p
12MHz	250p
13MHz	350p
14.318MHz	175p
15MHz	200p
16.00MHz	250p
18.00MHz	200p
18.432	150p
19.968MHz	150p
24MHz	175p
26.690MHz	150p
27.145MHz	200p
38.6667MHz	175p
48.0MHz	175p
55.5MHz	400p
116.0MHz	300p

KEYBOARD ENCODER

AY-6-2376	700p
74C922	500p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

BAUD RATE GENERATOR

COM 8116	£8
MC 14411	£7

TELETEXT ICs

SAA5020	£6
SAA5030	£9
SAA5040/1	£16
SAA5050	£9

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

CONNECTION SYSTEMS

JUMPER LEADS

24" Cable with Headers

	14pin	16pin	24pin	40pin
Single end	145p	165p	240p	380p
Double end	210p	230p	345p	540p

Cable with Sockets

	20pin	26pin	34pin	40pin
Single end (24")	160p	210p	270p	300p
Double end (18")	290p	385p	490p	540p

34 Way Edge Conn (36") One End £5.50
D. Conn 25W 24" M: £5. *F*: £5.50

IDC CONNECTORS

(Speed block) Type	10 Way	26 Way	34 Way	40 Way
Header plug	90p	200p	240p	270p
Receptacle	90p	200p	240p	270p

EUROCONNECTORS

	Plug	Skt
DIN 416122 × 32 Way	300p	350p
Angled 2 × 32 Way	350p	400p
3 × 32 Way	370p	430p
Angled 3 × 32 Way		450p
DIN 41617 31 Way	200p	200p

(for 2 × 32 Way please specify A + B or A + C type)

DIL HEADER PLUGS

	14pin	16pin	24pin	40pin
Solder type	50p	60p	100p	275p
IDC type	130p	140p	200p	285p

MIN D CONNECTORS

	9	15	25	37
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	345p	375p
angled	175p	240p	310p	500p
Hoods	100p	100p	100	150p

DIL SWITCHES

4 way	90p
8 way	120p
6 way	105p
10 way	150p

ZIF SKTS

24 pin	£6
28 pin	£8
40 pin	£10

EDGE CONNECTORS

	0.1	0.156
2 × 18 Way		150p
2 × 22 Way	310p	170p
2 × 23 Way	335p	—
2 × 25 Way	210p	200p
1 × 43 Way	260p	—
2 × 43 Way	350p	—
1 × 77 Way	700p	—

ACORN ATOM

Basic Kit **£120** Built **£135**
Fully Expanded 12K + 12K **£188**
p&p **£2.50**/unit
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Phone for details on Atom Accessories

TRANSISTORS

AD161/2	45p	BFX84/5	40p	TIP33A	70p	2N3054	65p
BC107/8	13p	BFX86/7	27p	TIP33C	80p	2N3055	48p
BC109C	14p	BFX88	27p	TIP34A	90p	2N3442	140p
BC117	20p	BFX89	180p	TIP34C	120p	2N3553	240p
BC147/8	9p	BFY50	24p	TIP35A	120p	2N3584	250p
BC149	10p	BFY51/2	24p	TIP35C	140p	2N3643/4	48p
BC157/8	10p	BFY56	33p	TIP36A	140p	2N3702/3	12p
BC159	11p	BFY90	80p	TIP36C	150p	2N3704/5	12p
BC169C	12p	BRY39	45p	TIP41A	50p	2N3706/7	14p
BC172	12p	BSX19/20	24p	TIP41C	55p	2N3708/9	12p
BC177/8	17p	BU104	225p	TIP42A	60p	2N3773	300p
BC179	18p	BU105	190p	TIP42C	65p	2N3819	25p
BC182/3	10p	BU108	250p	TIP54	160p	2N3820	40p
BC184	11p	BU109	225p	TIP120	75p	2N3823	50p
BC187	30p	BU126	150p	TIP121	75p	2N3866	90p
BC212/3	11p	BU180A	120p	TIP122	80p	2N3902	700p
BC214	12p	BU205	200p	TIP142	130p	2N3903/4	16p
BC237	15p	BU208	200p	TIP147	130p	2N3905/6	16p
BC327	16p	BU406	145p	TIP2955	78p	2N4037	65p
BC337	16p	BUX80	£6	TIP4055	70p	2N4123/4	27p
BC338	16p	BUY69C	350p	TIS93	30p	2N4125/6	27p
BC461	25p	E310	50p	ZTX108	12p	2N4401/3	27p
BC477/8	30p	MJ802	£4	ZTX300	13p	2N4427	90p
BC516/7	40p	MJ2501	225p	ZTX452	45p	2N4871	60p
BC547B	14p	MJ2955	90p	ZTX500	15p	2N5087	27p
BC548C	12p	MJ3001	225p	ZTX502	16p	2N5089	27p
BC549C	16p	MJ4502	£4	ZTX504	18p	2N5172	27p
BC557KB	14p	MJE340	60p	ZTX552	55p	2N5191	90p
BC559C	16p	MJE2955	100p	ZTX652	60p	2N5194	90p
BCY70	18p	MJE3055	70p	ZTX752	70p	2N5245	40p
BCY71/2	22p	MPF102	40p	VN66AF	72p	2N5298	65p
BD131/2	50p	MPF103/4	30p	VN10KM	60p	2N5401	60p
BD135/6	40p	MPF105	30p	VN66	80p	2N5457/8	40p
BD139	40p	MPSA06	30p	2N697	25p	2N5459	40p
BD140	40p	MPSA12	50p	2N698	45p	2N5460	60p
BD189	60p	MPSA13	50p	2N706A	30p	2N5485	44p
BD232	60p	MPSA20	50p	2N708	30p	2N5875	250p
BD233	75p	MPSA42	50p	2N918	45p	2N6027	48p
BD235	85p	MPSA43	50p	2N930	18p	2N6052	300p
BD241	60p	MPSA56	32p	2N1131/2	36p	2N6059	325p
BD242	60p	MPSA70	50p	2N1613	25p	2N6107	65p
BD677	40p	MPSA93	40p	2N1711	25p	2N6247	190p
BF244B	35p	MSPU06	63p	2N2102	70p	2N6254	130p
BF256B	50p	MPSU07	60p	2N2160	350p	2N6290	65p
BF257/8	32p	MPSU45	90p	2N2219A	25p	2SC1172	150p
BF337	30p	MPSU65	78p	2N2222A	25p	2SC1306	100p
BFR39	25p	TIP29A	35p	2N2369A	25p	2SC1307	150p
BFR40/1	25p	TIP29C	40p	2N2484	30p	2SC1957	90p
BFR79	25p	TIP30A	35p	2N2646	45p	2SC1969	150p
RFR80/1	25p	TIP30C	40p	2N2904/5	25p	2SC2028	95p
BFR96	180p	TIP31A	40p	2N2906A	25p	2SC2029	250p
BFX29	40p	TIP31C	45p	2N2907A	25p	2SC2078	200p
BFX30	27p	TIP32A	45p	2N2926	9p	2SC2335	250p
		TIP32C	40p	2N3053	30p	2SC2612	250p
						3N128	120p

3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
BYX36.300	20p
OA47	8p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
1S920	9p

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1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

ZENERS

2.7V-33V

400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	180p
2N5060	30p
2N5064	35p

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* MICROPROCESSOR TRAINER *

(As published in Wireless World Jan 81)

This micro computer based on 6802 processor and only 8 other ICs, provides up to 4K EPROM, 1K RAM, PIA, 6 digit display and up to 8 monitor commands. Though designed as a trainer Nandcomp can be used as desktop computer and a software development tool. The spare EPROM space allows modification for dedicated control or calculator application.
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CZECH ON CALCULATOR PRICES

ETI NEWS MAY 1976

A typical dour Czech day. The rain sleets across Prague.

Somewhere in the back streets well away from the patrols and the populace, Ivan scuttles into a dingy corner shop.

There, amid the Western papers and naughty mags, he spots the object of his desires.

Eyes alight he lifts the proscribed machine from the rack, and carries it reverently to the counter, behind which stands the owner.

''How much?'' he stammers, hands shaking.

''Novus 650 comrade? To you, £172. Crossed the border this morning right under the army's noses.'' he looks around furtively, and leans across the counter, whispering.

''Interested in the REAL thing eh comrade? ''Ivan nods. The man reaches below the counter and produces a battered show box. Ivan's eyes are wide by now, riveted to the lid as it lifts. Inside lies a full frontal scientific, a HP 45.

Ivan faints.

Now before you dismiss this as merely the alcoholic follies of the ETI staff, following a party, let us inform you dear reader, that whilst we may be guilty of slight embroidery, our flight of fancy is based on fact.

It seems our Eastern friends consider pocket calculators to be highly prized items, and will pay vast sums to acquire them. What would cost you or I £7, our Ivan would need £172 to own. For that HP 45 you could possibly get a weekend with Siberian Sue, belle of the Balkans.

The reason behind this black marketing and smuggling is that calculator ships are not produced behind the ferric curtain and the machines are banned from importers lists by the governments, to preserve foreign exchange as their value is so high.

I wonder how they count it?

FOUR CHANNEL DISCS

In the UK the EMI group have announced plans to release quadraphonic discs — using the CBS developed 'SQ Matrix' system — in April.

The company claims that the new discs will be fully compatible with existing stereo equipment.

ETI NEWS APRIL 1972

COMPUTER 'ON A CHIP' WITH CASSETTE TAPE

A new byte-orientated micro-computer with its own in-built cassette tape backing storage has been produced by Computer Electronics Ltd, of Saffron Walden, Essex, as part of its range of cassette tape data systems.

Believed to be one of the first 'processors on a chip' computers to be developed in this country, the complete computer fits on one of the company's standard printed circuit cards. ETI NEWS AUG 1973

CALLING ALL K9s, R2D2s, ROBBIES, C3POs, MICROMICE etc, etc.....

ETI is very keen in getting a robot dialogue going.

Anyone out there on the other side of the printers ink interested in robotics, especially anyone actually building robots - of WHATEVER complexity - should contact us here at ETI.

If possible how about some photographs of your machines? They may well be in line for an appearence in ETI. So come on, lets be hearing from you - ALL of you - take pen in hand (or get the robot to do it) and write to

The Editor,
ETI Magazine,
145 Charing Cross Road,
London WC2.

Mark your envelope ''ROBOTS''

So we can deal with it with our usual machine - like efficiency.

ETI NEWS NOV 1979

TV GAMES LSI CHIP AVAILABLE SOON

Rumours have been abounding for about a year now that an LSI chip for television games was being developed.

We now have definite news that Logic Leisure, a British Company, have produced a chip which will produce four TV games, with two variations on each, giving eight permutations. There is score and sound facility. Type number is not yet known but the chip is suitable for both 625-line, 50Hz and 525-line, 60Hz.

It is hoped that the chip will be on sale in October and the price tag is going to be in the £10-£12 range (plus VAT). U.K. distributorship is in the hands of Television Sprots Co. Ltd., 6 Half Moon Street, Mayfair, London, WIY 7RA.

ETI NEWS AUG 1975

brief news

NASA have received weak signals from Skylab for the first time in four years. The possibility of sending it deeper into space is being considered....

★ A study by the American National Institute for Occupational Safety and Health (Niosh) has concluded that VDUs in use in the offices of the New York Times are not responsible for cataracts developed by two copy editors working there....

ETI NEWS SEPT 1978

Hitachi MAGic

Hitachi have developed an experimental colour video camera combined with a video tape recorder — provisionally christened the 'MAG Camera'. Using high density recording techniques, the combination is little bigger than an 8 mm cine camera. The cassette, using ¼" tape, is almost as small as an audio cassette and allows two hours of recording/playback. The complete unit weighs only 2.6 kg, including a rechargeable battery pack. Watch this space for news on development of the MAG Camera.

ETI NEWS JAN 1981

BRITISH? PRECISELY!

From a firm called James Niell comes the Micro 2000 to rise into our News Digest with carefully measured precision. This instrument gets our vote for the best innovation of the year already! A digital *micrometer* no less.

As you can see from the picture, it actually reads out a measurement in seven-segment format. Goodbye verniers. It has so many features and advances, it is perhaps best simply to list them.

Accuracy to ± 0.002 mm., with a 'constant force' spindle and self-calibration facility. As soon as it is switched on, the 2000 self zeros.

The zero reset means that it can be used as a comparator against a known standard, and variations from that can be read directly. Also in awkward situations, the instrument can be zeroed, utilised, and then removed to be read.

ETI NEWS JUNE 1977

Sat 54

Well, it was Satcom 3 actually, but the plot is reminiscent of that old, old American telly series. The Car 54 in this case, however, was an RCA communications satellite, last heard of in December, 22,000 miles above mother Earth.

If anyone finds a communications satellite answering to the name of Satcom 3, send it to RCA, nto us. Mind you, if it has gone up in a puff of smoke, it has probably burned up on its way back to Earth. NASA quick to assure us that it won't cause another Skylab incident. So, you needn't dust off your anti-Skylab umbrella, yet.

ETI NEWS MARCH 1980

Text To Talk

KurzwellComputer Products of Cambridge, Massachussetts has developed a machine to turn written text into speech.

The machine contains an optical scanner, a small computer, a small synthesiser and a loudspeaker unit.

The page to be read is placed over the scanning unit which then converts the written text to digital signals for the computer. The computer then converts them into sound

ETI NEWS APRIL 1980

junk calls

From the land that brought us Muzak and MPUs comes the Junk call — the same as Junk mail but verbal! A machine is being used to dial up to 1,000 numbers a day and make a pre-recorded sales pitch, unlike junk mail there is no way of knowing when the call will be junk or not. By dialing up numbers from 0001 to 9999 the machine annoys everybody who answers on a particular exchange, even if you hang up it holds the line open until the pitch is finished — this has caused emergency calls to be delayed in some cases.

Ten states are considering legislation to curtail the activities of the machines. However they intend to exempt charities, pollsters and politicians. Some people want an electronic 'no thanks' sign to be developed, although nobody is quite sure how it would work. What next?!

ETI NEWS SEPT 1978

HP AT A (CALCULATED) LOSS;

Hewlett-Packard — renowned for their up-market calculators, are apparently running this section of the business at a loss. Equipment and other activities are keeping then in the black, and H.P. cite the delays occurring on the introduction of new models as the cause for this. Also named as a culprit is "severe price erosion in the pocket calculator marketplace". Pick the bones out of that ye rivals of the beast.

ETI NEWS NOV 1976

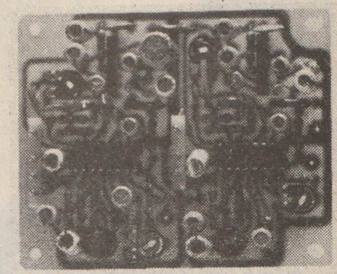
★ A computer system capable of controlling the lighting and heating in up to one hundred buildings has been set up in London by Honeywell. The system, called BOSS, is the first of its kind in the UK . . .

ETI NEWS MAY 1978

ANRS INTEGRATED INTO A SINGLE IC CHIP

In 1972, JVC first introduced their Automatic Noise Reduction System (ANRS) into their top-range cassette decks. Since then, ARNS has been incorporated into a wide range of tape decks. Recent improvements however, in cassette deck quality and the possibility of "noise-reduced" FM broadcasts have meant improvements in the quality of noise reduction systems and the application of these systems to components other than cassette tape decks.

To meet these new requirements, JVC has recently completed the development of the ANRS IC.



ETI NEWS OCT 1975

CEEFAX AND ORACLE SYSTEMS COMBINED

The BBC and IBA, together with BREMA and the Broadcasting Department of the Home Office have agreed on a unified system of data broadcasting.

Until now the BBC have been working on CEEFAX, the IBA on ORACLE. Both systems allow a TV viewer to select at will from a number of different 'pages' of information and put these onto his screen.

ETI NEWS JULY 1974

ELECTRONICS ENGINEERS' SALARIES FALL BEHIND

The 'Survey of Salaries', published by the Management Survey Centre this August, shows that the salaries of electronic engineers working for large companies have stagnated whilst other engineers' salaries have increased. Senior chemists have done best - their salaries have increased 3-4 times more quickly than the average.

For a senior professional in development (with major responsibilities) the median salary is £4,174; for electronic engineers in particular the median at this level is £3,720.

ETI NEWS OCT 1973

A Preview from the Next Issue of

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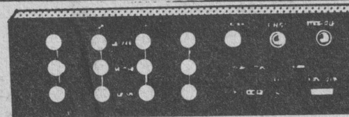

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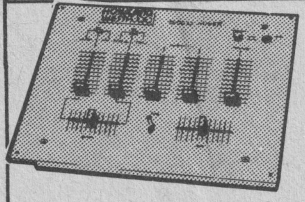
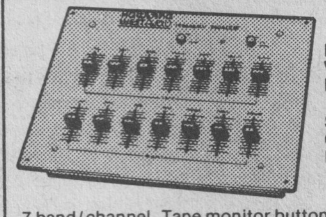


HOWLAND WEST MX750

4-channel STEREO DISCO MIXER

Switchable phono/line i/ps. Cross fade on decks. P.F.L. on deck i/ps. Master volume control. Mains operated.

£59.90 (p & p£2.00)



HOWLAND WEST MX850

STEREO GRAPHIC EQUALIZER

7 band/channel. Tape monitor button. 12DB boost and cut (each band). Mains operated.

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HOWLAND WEST MX950

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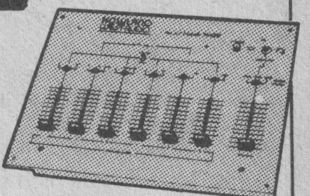

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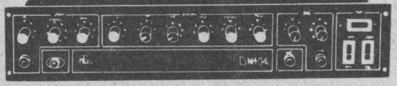

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HIGH QUALITY DISCO MIXER
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Headphone monitor facility. **£34.90** (p&p £1.50)
Requires power supply (30V-50V DC).
Suitable power supply available **£5.99** (p&p 75p)

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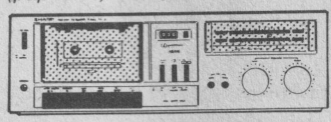

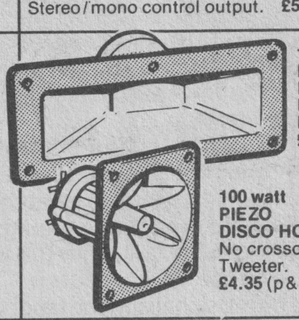

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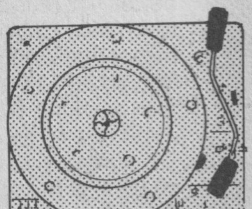

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THE MUSIC MAKERS

TAKE ADVANTAGE OF THE HY-TEK PRICE POLICY

AUDIOPHILE

Soon burglars won't be bothering to nick your whole hi-fi; they'll just take the cartridge. This month Ron Harris reviews two new pickups, one with a gemstone cantilever and the other a work of modern art.

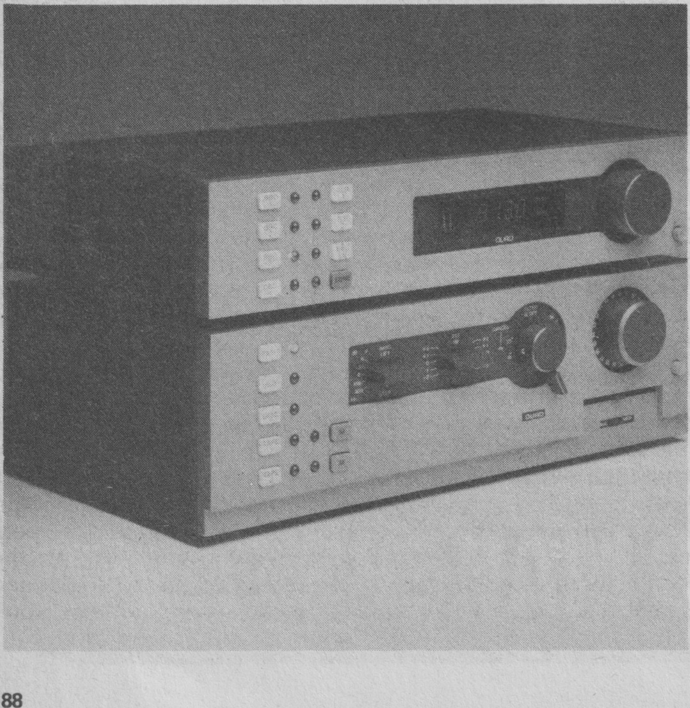
News just in of a new piece of British circuitry genius. This is a new protection circuit, soon to be added to a famous manufacturer's product, which is claimed to make an amplifier totally invulnerable electrically.

Totally in this case means "even from 240 V mains at input or output". Ultra-fast relays are set at the output and on the supply lines to the PCB. These are driven from the new circuit, which has as its final stage a voltage amp with an incredibly high slew rate. This ensures a high speed of operation for the relays.

Out Of Phase

The protection circuit operates like this: if an amplifier is suddenly faced with a massive input signal, the ratio of the feedback signal to input will drop dramatically. A comparator senses the change and a 'low-feedback' signal is generated. This by itself is sufficient to trip the supply relays, so that the overload cannot be passed on to the output stages, thus destroying them — and probably the speakers.

A second block within the circuitry watches the supply rails and any surges which are outside the requirements of normal drive will trip the protection circuit, since this is a "low-feedback likelihood situation" as the designer puts it. Great play is made of the fact that the music signal and the feedback voltage are in anti-phase at the point of comparison, so no interaction within the buffer is likely. 'Anti-phase reset', as it is called, thus introduces no colouration. Hence the protection reset of the relays can occur either in the case of low feedback-to-signal ratio, or in event of an "overload likelihood". I suppose this is where the somewhat pompous title of the circuit is derived — **A**nti-**P**hase **R**eset **I**n **L**ow **F**eedback (**O**r **O**verload) **L**ikelihood.



At long last Quad have released their new tuner, the FM 4. It was shown for the first time at the Audio 82 exhibition in Swiss Cottage recently. Designed to match the Quad 44 control unit (preamp to the rest of us) the FM - only unit has digital tuning and seven pre-set stations. Programme locations are stored in memory.

A tuning knob has been retained in preference to a set of push-buttons, since Quad say it is easier to use.

Brief Specification:

Full limiting	1 V	IF Rejection	100 dB
S/N (1 V input)	7 dB (stereo)	AM Supression	60 dB
Distortion (1 KHz)	0.15%	Image Rejection	80 dB
Capture Ratio	2.5 dB	Crosstalk (1 KHz)	40 dB

Shure MV30HE

A dedicated offshoot of the renowned V15 IV design, the MV30HE is for use in the SME Series III or IIIS only. The cartridge is built into a SME carryarm such that no headshell is used, or needed.

The moving components are those of the V15, save that no damper is provided. The cartridge body is all new, however, and quite a few problems it must have given them getting the coils and poles into a body as slim as this. The design is so arranged that the point of bearing intersection and the stylus line up parallel to the record. This will tend to aid stability in the replay of warped records.

As in the V15 a hyperelliptical stylus is used, which will give lower distortion results than either a spherical or elliptical tip. Tip mass is commendably low and output level is on a par with the V15 IV.

Once fitted into the SME the MV30HE looks very smart indeed is and visually extremely classy!

Testing an Armful

In the lab the MV30HE had an easy time passing just about every test. It tracks as well as the V15 IV and measures slightly better. There is no higher technical accolade than that. The LF resonance came out — surprisingly — at around 16 Hz, a little higher than optimum in my opinion. Best values are somewhere around 10-12 Hz so as not to affect extreme LF reproduction. Best tracking was obtained at around 1.0 g, and no improvement was forthcoming for increased force.

Frequency response was boringly perfect at 20 Hz — 20 kHz ± 1.3 dB with a separation figure of 27 dB at 1 kHz. Compliance measured very high at 34 cu, so only the smallest damping paddle is required. It *is* required however — see later.

Instructive Stuff

The instruction booklet is worth a special mention. It is a straight 'copy' of the SME style, right down to the little diagrams with ticks and crosses for right and wrong answers. Some sort of deal has been struck here, methinks!

One point that I just *have* to mention here; I could not,

The MV30HE set up in a Series III. About the best looking piece of hi-fi you'll ever see. As the compliance is very high only the smallest damper paddle is required, despite the lack of dynamic stabiliser (as fitted to V15 IV).

in any circumstances, get the arm to balance out using the recommended mixture of weights and spacers in the SME. Despite Shure patiently showing me the same arm set up perfectly in *their* Series III, would it balance once I left the factory? It would not!

I would be most interested to hear from any MV30HE purchaser as to balance requirements. I agree the total mass is 11.8 g but I'll be damned to an eternity of music centres playing Barry Manilow before I'll agree that an MV30HE balances in an SME Series III with four weights and six spacers.

Down To Sound

I suppose the obvious comparison with the MV30HE must be the V15 IV. So, as I'm getting old and predictable (I *still* hunger after Felicity Kendal . . .) that was the first pickup against which I auditioned the unit. Frankly, I had expected to discern no difference, and initial tests confirmed this to some degree. However, having settled in at home with my own system around me and the reassuring brandy in hand, subtle differences began to manifest themselves. The MV30HE has a more coherent sound — the mid-range is more open under close examination and the bass is 'cleaned-up' and tighter, if a little more prominent. These are *exactly* the changes to be expected from a unit which simply matches the arm better, but has a higher resonance. Which, of course, if I'd thought about, is *exactly* the MV30HE/V15 IV relationship. Serves me right for being so sure of myself!

In comparison to the market as a whole, the MV30HE/SME pickup stands well-up with the best. The damper is not significantly missed, provided the SME paddle is employed. Leave it off and boom is liable to result, as is a certain lack of stability on warped records. A limited application, then, but a very creditable performance and one which will compete with Shure's own V15 IV. After all, if you've got an SME and were contemplating a V15 IV, the MV30HE is a better bet all around. It is no more expensive than the V15 IV with a CA1 arm to hold it and it provides a cleaner, more refined performance. All in all, a nice touch Shure. Whither goest thou now?

Dynavector Karat Ruby

Both this month's cartridges are unusual in their own way; Dynavector's Karat is notable for its gemstone cantilever. This 2.5 mm long piece of single-crystal ruby is cut with a laser to accept the stylus (diamond) and then allowed to cool, thus fixing the stylus in place. The length is remarkably short, since Dynavector say that the less material the stylus information has to pass through, the higher will be the fidelity of the output.

Wave propagation through a medium is something not many of us take up as a hobby, but someone down at Dynavector must have it all well sussed! Apparently this equation:-

$$\frac{EI}{m}\frac{\partial^4 y}{\partial x^4}+\frac{\partial^2 y}{\partial t^2}-\rho\frac{EI}{m}\left(\frac{1}{E}+\frac{\gamma}{G}\right)\frac{\partial^4 y}{\partial x^2 \partial t^2}+\frac{\rho^2\gamma}{mG}\frac{\partial^4 y}{\partial t^4}=0$$

$$C_B=\alpha\sqrt{2\pi f}\left[1-\frac{1}{4}\beta\frac{2\pi f}{\alpha^2}+\frac{1}{4}\delta(2\pi f)^2+\cdots\cdots\right]$$

where E = Young's modulus; I = secondary moment of section area; G = shear modulus; m = mass per unit length of a cantilever; p = density of the cantilever material; x = distance from the end of the cantilever; y = flexural displacement of the cantilever; r = constant; t = time.

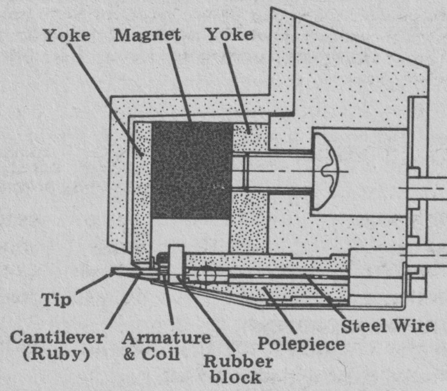
sums up the vibrational behaviour of a cantilever under dynamic conditions. It can also be used to prove that rigid materials, such as ruby and diamond, make for better cantilevers than boron, berylium and the rest.

(There is a 'big brother' to the Ruby, which has a diamond cantilever and costs around £450 as opposed to the Ruby's £100. If I can persuade the ever-helpful Dynavector into lending one I hope to report on the differences soon. Maybe if I say "please". . .?)

Temperate Zones of Test

Another piece of original thinking has gone into solving the problem of temperature dependence and damping material. The only rubber used in the Karat is to prevent the cantilever taking its jewelled self up into the body whilst playing records. Normally the pivot damping in a cartridge is accomplished by a rubber block and this is prone to suffer from changes in temperature and slow deterioration as it ages — the Karat suffers neither of these weaknesses.

In fact, due to the short rigid construction of the cantilever, the Ruby requires no damping at all.



Cross-section of the Karat Ruby.

Under test the Karat showed a ruler flat response from 100 Hz to 30 kHz of under ± 0.5 dB! It was only 1 dB down at 30 Hz and separation measured an excellent 24 dB at 1 kHz and a more than adequate 18 dB at 20 kHz. Stylus resonance fell at 49 kHz and in the SME Series III (what else?). LF resonance was well placed at 12 Hz, below audibility and above warps.

Tracking was exemplary for a moving-coil unit — at 1.75 g it tracked all my test bands perfectly; the first moving coil to do so. Bias was set for 2.0 g, a high value, but one that worked well. In actual use the Karat was never caught out by any recorded information.

If at this point you're looking around the pages in search of the usual response graphs, don't bother — I haven't included any. If you really want to see a straight line, go buy a ruler. Dishearteningly disappointing for us cynics.

Listening Out

As the Karat Ruby matches the SME Series III so well, it was left in that arm all through the listening test. One brief excursion into a Linn Itokk showed the two to be completely incompatable in my opinion, as the sound stage broke up and the bass became so loose as to be positively flapping! Strange that, as both are capable of much better and there is little on paper to point to such obvious mutual abhoration.

The loudspeakers used were my trusty KEF 105 II's fed by a variety of amplification from Crimson, Monogram and Trio. Source equipment remained at Thorens 160S/SME III throughout.

On the very first LP side I played with the Ruby it was obvious that here was something special. The sound is so detailed and open, with such tight control of the bass that it makes you sit up and take notice of the music. This is a cartridge that will be much appreciated by reviewers, as it is so easy to listen *through* for long periods.

In fact there is little I can say against the Karat. It is a trifle recessed — I cannot account for this impression from the lab results, however, but it remains a definite impression — but is so relaxed and balanced a sound that none but the most obnoxious could find aught to quibble with. The sound quality reminded me greatly of the Ortofon MC30, but with greater resolution of complex passages and a more extended bass end.

At around £100 the Karat Ruby is an excellent bargain. Even accounting for the required step-up device, this pickup is required listening for anyone in the market. I have no hesitation in saying that it out-performs many units costing much, much more and will give more musical pleasure than just about any other cartridge I know.

Mind you, I haven't heard the Karat Diamond yet. . . but can it *really* be worth £350 more? On this evidence I would doubt it! (Pause while Dynavector work out whether this is a compliment or an insult. . .)

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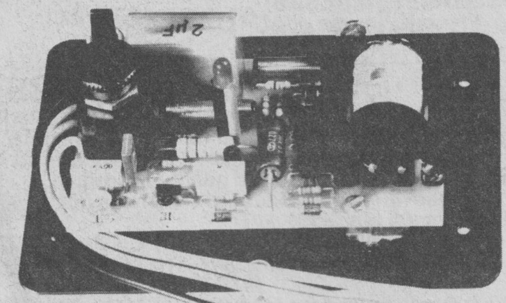

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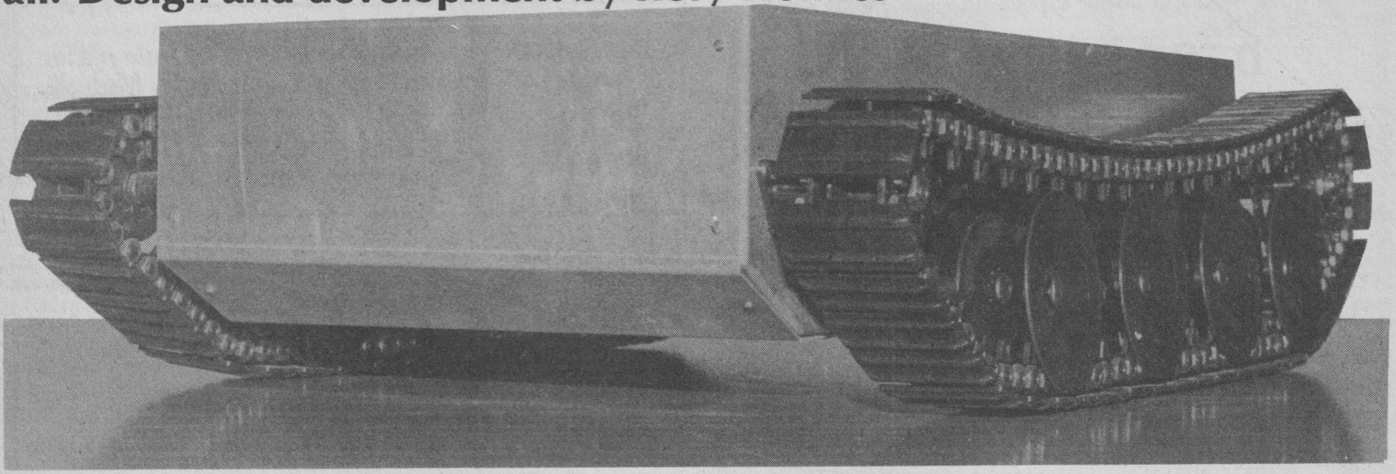
ROBOT MOTOR CONTROL

This month we feature a control board for last month's motor driving board. This is part 2 in a series of DIY robot modules — collect them all! Design and development by Rory Holmes.



In this second part of the series on the ETI intelligent programmable mobile we shall describe the design of an analogue pulse width modulator for controlling the motor driver stage featured last month. We shall also take a brief look at some of the modules being offered later in the series which can be added in stages to enhance the motorised vehicle. The intention is to build up to a complete computerised mobile.

A lot of flexibility has been allowed for in the actual use and configuration of the modules, as we are well aware that constructors interested in this type of project have firm ideas of their own on the final form and capabilities of their mobile. Construction and interconnection details for all the modules we are presenting will be given along with guidelines to a range of applications.

The facilities we have planned for the mobile will continue with the digital motor control and an on-board programmable computer for overall control of other modules. A lightweight manipulator arm complete with teaching arm has also been designed, for mounting on the front of the mobile. It is powered by four radio control servo motors and the electronics interface between the servos and computer will be described along with details of the arm mechanics. Optical proximity detectors for object sensing, and infra-red tachogenerators for speed sensing will also be featured on the ETI mobile.

It is hoped that the designs will also prove useful as stand-alone modules for individual use in other applications. Optical proximity detectors, for example, have numerous applications in batch counting, limit sensing, detection, alarms and so on.

The digital pulse width modulator in next month's issue will find many uses in the control of analogue functions; how about a computer interfaced to a pulse width modulated optical data link, for analogue information transmission? Our version will control two pulse width modulated channels, with a resolution of one part in 256, via an eight bit data port; modulation being achieved solely by logic to satisfy the all-digital purists.

Optical Proximity Detectors

These have been designed as small independent units with as much in-built versatility as possible. The circuitry is housed in a short length of aluminium tube axially aligned in the detector direction, with three external connecting points; ground, positive supply, and an open collector digital output. A number of detectors can thus be easily mounted in strategic locations. All circuit operating parameters are independent of the supply voltage, which can be anywhere between 5 and 35 V at a current of 20 mA.

The proximity switch works on the principle of transmitting and detecting a modulated infra-red beam. The infra-red transmitter receives 1 A peak current pulses, of 10 uS duration, with a modulation frequency of 1 kHz. The 100:1 duty-factor thus achieved allows high currents to be used to increase the detection range, while reducing the average supply current to only 10 mA.

The sensor can be set by a preset pot, accessible through a small hole, to detect an object at any distance in the range 1 cm to 35 cm.

A small amount of hysteresis is introduced into this switching distance to ensure clean switching thresholds and stability of the output signal. The use of tuned detector amplifiers provides excellent infra-red interference rejection.

Analogue Speed Control

The analogue speed control has

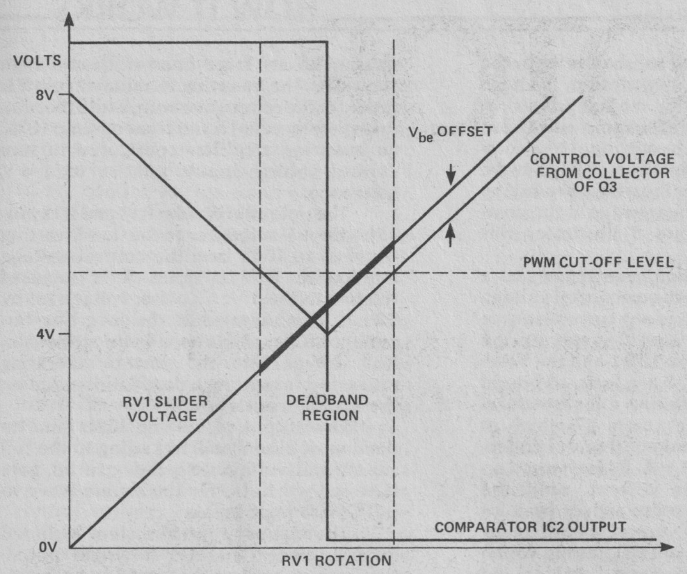


Fig. 1 Various voltages associated with the circuitry around Q3. The control voltage is measured at point A in Fig. 5.

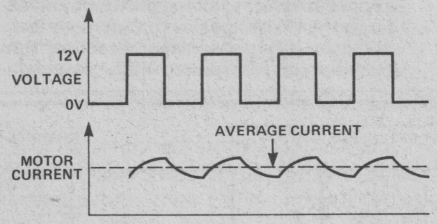


Fig. 2 PWM motor driving waveforms for last month's circuit.

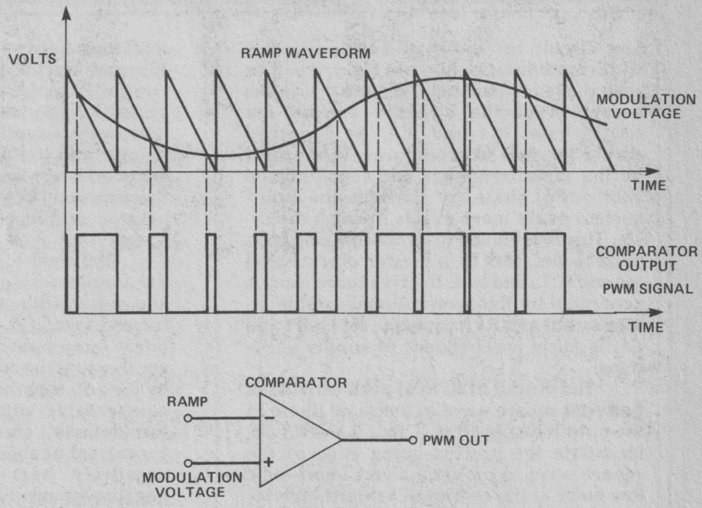


Fig. 3 How PWM waveforms may be generated using a comparator.

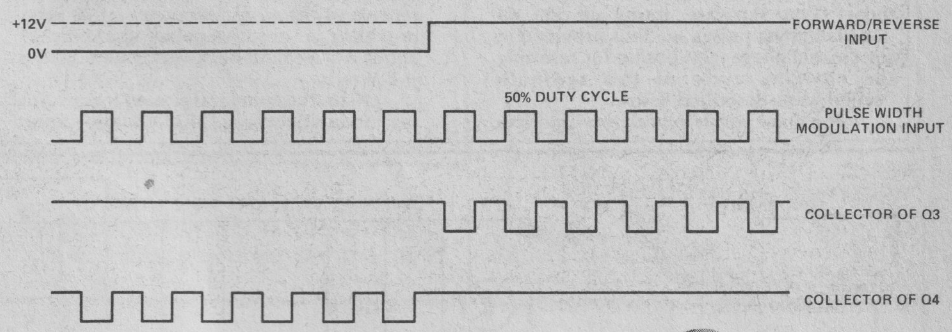


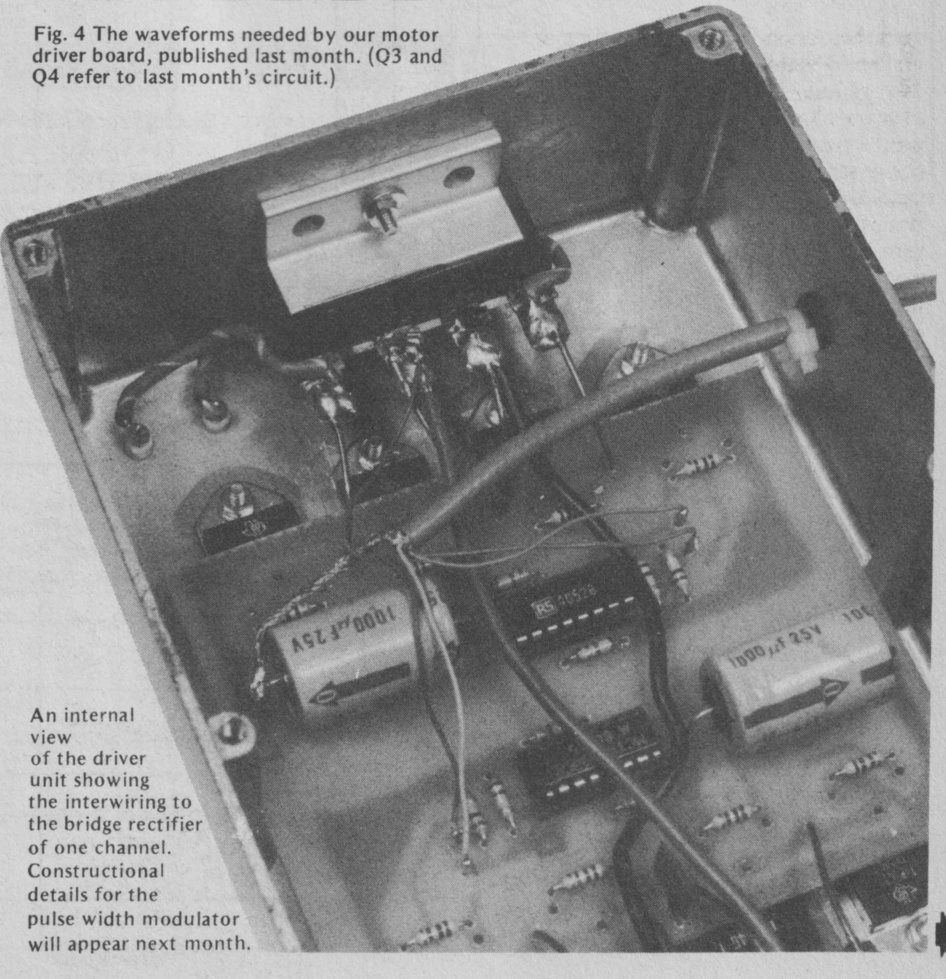
Fig. 4 The waveforms needed by our motor driver board, published last month. (Q3 and Q4 refer to last month's circuit.)

been devised for manual control of the main traction motors; it provides two pulse width modulated signals suitable for the motor driver amplifier.

The circuit is designed to provide a linear control-voltage-to-pulse-width relationship for greater flexibility in application, and to simplify the addition of speed feedback velocity control.

The modulator can be built either single or dual, and the manual control section, if not required, is easily omitted. Speed control is achieved via two remote potentiometers, allowing speed to be set in either forward or reverse directions independently for each traction drive.

Since both motors are controlled via switching amplifiers from the same battery supply, it is important to reduce the peak currents that are drawn. This can be achieved by offsetting the phase of the switching waveforms relative to each other, such that at 50% duty cycle modulation, power



An internal view of the driver unit showing the interwiring to the bridge rectifier of one channel. Constructional details for the pulse width modulator will appear next month.

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The circuit for the dual analogue pulse width modulator is shown in Fig. 5; it will be seen that each channel is identical with the exception of the circuitry around the CMOS gates IC1 and IC4. As described earlier the two switching waveforms must be the same frequency and synchronized 180° out of phase, to distribute the motor current peaks more evenly through the cycle. This is achieved by synchronizing both pulse generators to a master clock based around IC1a and b. A 20 kHz square wave is generated by this conventional astable arrangement and its frequency, set by R1 and C1, is fairly independent of supply variations.

The output of IC1d at pin 6 provides a buffered square wave in the same phase as the output on pin 10 of IC1b. C2 and R3 differentiate the positive-going edge of the square wave to produce a very short logic low pulse at the output of Schmitt inverter gate IC1c. In similar fashion C9 and R16 produce a logic high pulse coinciding with the negative-going square wave edge. IC4b further inverts this signal to a logic low pulse. Two separate trains of 500 nS negative-going pulses are thus provided in the correct phase relationship for resetting the charging cycle of two sawtooth oscillators as described below.

The pulse width modulators are identical from here on and we shall refer to the topmost circuit for description. Voltage controlled pulse width modulation is, in principle, very simple; a ramp waveform (sawtooth) is applied to one input of a comparator and the modulation voltage to be encoded is applied to the other, producing the required PWM squarewave at the comparator output. Figure 3 illustrates this operation.

Due to the design requirement of a linear relationship between control voltage and pulse width, a constant current source formed from Q2 is used to generate the linear ramp waveform. LED1 and the base-emitter junction of Q2 are forward biased by R6 and together define a temperature-compensated voltage across R7 which in turn defines a constant emitter and collector current of about 1 mA. C3 is charged up negatively from this current, until the negative-going reset pulse arrives from inverter IC1c. This pulse turns Q1 hard on for a very short period (500 nS), during which C3 is completely discharged, taking the ramp voltage back to +8 V. This process repeats at the clock frequency of 20 kHz, providing a negative-going sawtooth of about 3 V peak-to-peak referenced to the +8 V rail.

IC3b, the comparator used to perform the modulation, is an LF353 dual op-amp, chosen for its large bandwidth and high slew-rate. The inverting terminal on pin 2 is fed from the ramp waveform, while the non-inverting terminal is fed from op-amp IC3a, an inverting amplifier configured to sum control voltage inputs relative to a 4 V reference.

The potential divider R11 and R12 provides the 4 V reference to the non-inverting terminal of IC3a, and the control voltage applied to R13 at point A is summed relative to the 4 V. An offset voltage set by PR1 is also summed at the inverting terminal of IC3a, and is used to bring the control voltage into the correct operating range and for setting a deadband region on the manual control pot RV1.

The output of op-amp IC3b (and indeed most others) will not swing to the full supply rail voltages, so the inverter gate IC1e is used to buffer the square wave to full CMOS logic levels.

The manual control system included in this circuit enables a single potentiometer to control the speed in both forward and reverse directions. When the pot is at centre travel, and for a certain deadband around this point, the motor must be stopped and no switching pulses should occur (ie the PWM signal is continuously low). As the pot is turned in either direction from its midpoint, the pulse width should in-

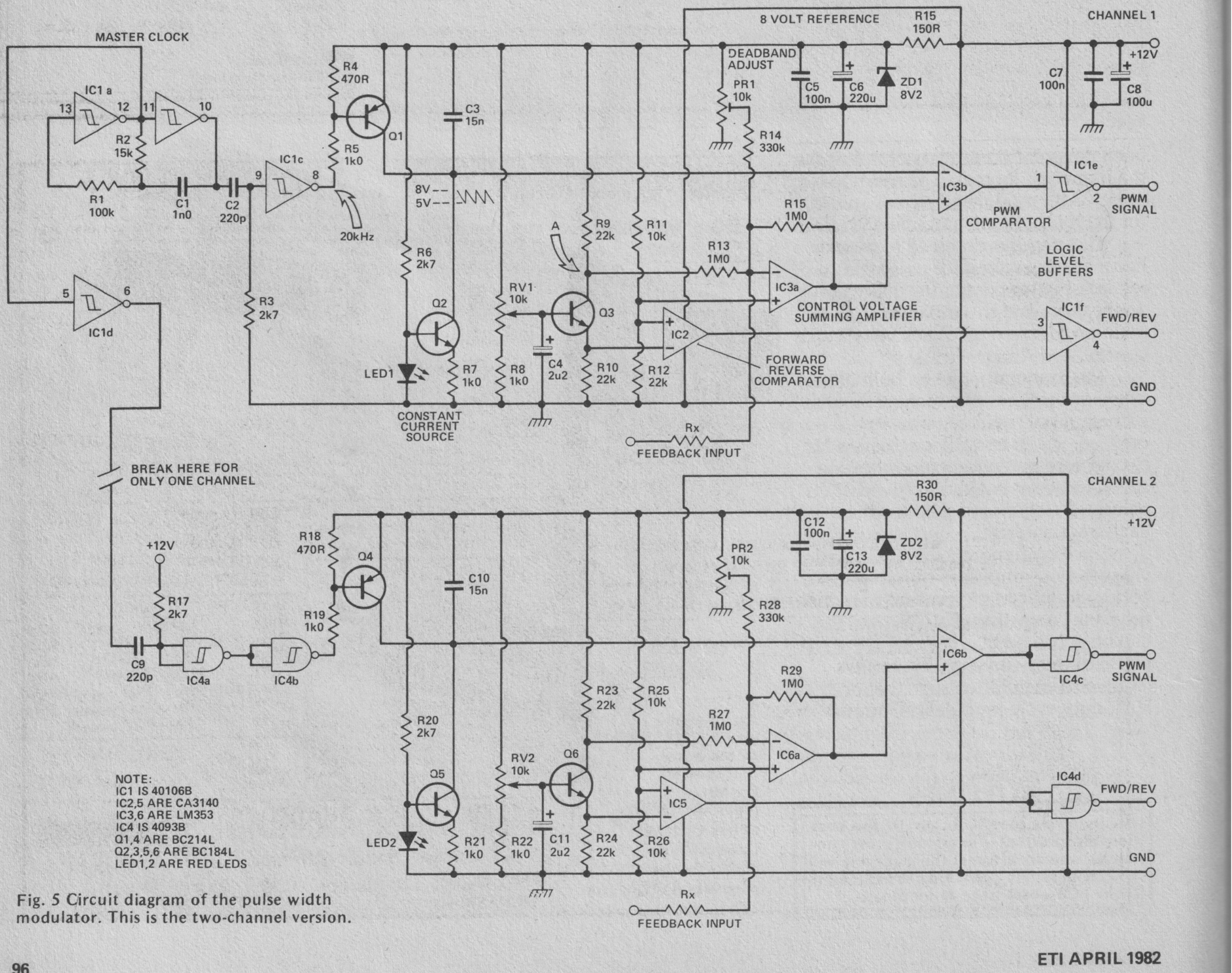

Fig. 5 Circuit diagram of the pulse width modulator. This is the two-channel version.

crease and this requires a positive-going input voltage to the summing amplifier IC3a. The forward/reverse logic level should also change state as the pot moves through its midpoint. Q3 provides the necessary voltage transfer function from the pot RV1 to the control voltage summing amplifier, as explained graphically in Fig. 1.

The emitter and collector resistors of Q3 are both equal and the base voltage is taken directly from the slider of the manual control pot RV1. The output voltage is taken from the collector of Q3 to feed the summing amplifier, and will be held at +8 V via R9 when Q3 is switched off. As the slider of RV1 moves toward the centre of travel, the base voltage rises, slowly turning on Q3 and lowering the collector voltage.

When Q3 is turned hard on as RV1 reaches its mid-point, R9 and 10 will form a potential divider giving 4 V as the minimum control voltage. Further increase of base voltage can now only increase the emitter and collector voltages back up to the positive rail, reaching a maximum at one V_{be} drop from the +8 V rail.

During the above process the voltage on the emitter of Q3 rises from zero to the same maximum voltage, and is fed to the inverting terminal of IC2, a CA3140 used as a comparator. The other comparator input receives 4 V derived from the potential divider R11 and R12. This provides the required forward/reverse signal that corresponds to each half of the control pot. Inverter gate IC1f buffers the output of IC2.

C7 and C8 provide supply decoupling for both channels, while C5 and C6 provide further smoothing for the 8 V zener regulator formed by R16 and ZD1. This 8 V reference rail is used for two reasons; firstly to allow for fluctuation in the 12 V battery power supply that would otherwise affect the output pulse width, and secondly to ensure that the op-amp supply voltage is well above the maximum input voltage.

The resistor marked as Rx in the circuit shows where a speed feedback voltage will be added to the controller to close the velocity control loop. An infra-red tachometer module to directly sense the traction speed will be described later in the series.

If the manual control input is not required, the components associated with this can be simply omitted (ie RV1, R8, R9, R10, C4, Q3, IC2 and their equivalents in the other channel). Control voltages may now be fed to the unconnected end of R13, where a variation of 3 V, set by PR1 to be anywhere in the range 0 V to 8 V, will provide 100% control of the output pulse width. Forward/reverse switching must also be applied to the input of IC1f on pin 3.

will be switched alternately to each motor. This spreads the current peaks more evenly over the switching cycle.

Construction and setting up with interconnection details for the motor driver will be described next month.

ETI

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R4,18	470R
R5,7,8,19, 21,22	1k0
R9,10,23,24	22k
R11,12,25,26	10k
R13,15,27,29	1M0
R14,28	330k
R16,29	150R
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PR1,2	10k linear miniature horizontal preset
Capacitors	
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C3, 10	15n polycarbonate
C4, 11	2u2 35 V tantalum
C5, 7, 12	100n ceramic
C6, 13	220u 16 V axial electrolytic
C8	100u 25 V axial electrolytic
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IC3,6	LF353
IC4	4093B
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3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
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47	40	17p
47	63	26p
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68	63	25p
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100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
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330	63	38p
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470	25	28p
470	40	33p
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2N2484	26p
2N2491	8.00
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2N2905A	29p
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2N2924	15p
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2N3392	27p
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2N3394	20p
2N3395	26p
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2N3405	21p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
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2N3448	6.56
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2N3568	50p
2N3569	50p
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2N3572	2.06
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2N3585	2.99
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2N3824	70p
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2N3905	15p
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2N4032	65p
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2N4061	10p
2N4062	10p
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2N4125	37p
2N4126	27p
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2N4903	3.24
2N4904	2.75
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2N4907	3.20
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2N4915	2.95
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2N5143	25p
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2N5226	25p
2N5227	25p
2N5232	30p
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2N5248	46p
2N5249	48p
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2N5295	1.37
2N5296	1.28
2N5298	1.37
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2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
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2N5366	25p
2N5367	28p
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2N5447	16p
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2N5450	23p
2N5451	25p
2N5457	35p
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2N5461	60p
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2N5484	40p
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2N5494	1.37
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2N6111	1.00
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2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
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3N128	1.98
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40325	2.46
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40346	1.30
40347	1.40
40348	1.95
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40361	50p
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40364	2.90
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40373	2.60
40374	2.84
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40394	1.10
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40407	1.10
40408	1.59
40409	1.70
40410	1.80
40411	3.00
40412	1.50
40422	2.95
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40513	1.75
40537	96p
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40594	1.15
40595	1.20
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40601	2.36
40602	1.68
40603	2.06
40604	1.85

40608	2.44
40622	1.45
40625	60p
40626	3.20
40631	1.90
40632	2.12
40635	1.35
40637	2.00
40643	1.80
40673	95p
40822	1.80
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AC127	25p
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AC187	25p
AC187K	28p
AC188	25p
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ACY20	75p
ACY21	75p
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ACY28	75p
ACY44	98p
AD136	7.90
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AD149	1.10
AD150	1.31
AD161	52p
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AF106	75p
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AF124	72p
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AF139	53p
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AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
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AF280	75p
AU110	2.20
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BC560	32p
BC560C	34p
BC727	44p
BC737	44p
BCW32R	60p
BCY30	1.15
BCY30A	1.30
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BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BYC33A	1.00
BCY34	80p
BYC34A	1.00
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BCY58	32p
BCY59	33p
BYC66	1.80
BYC67	2.00
BYC70	17p
BYC71	17p
BCY72	36p
BYC77	36p
BYC78	22p
BCY79	22p
BCY87	6.60
BYC88	4.90
BYC89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
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BD135	40p
BD136	40p
BD137	42p
BD138	42p
BD139	44p
BD140	44p
BD142	2.40
BD153	1.25
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BD157	1.20
BD158	1.40
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
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BD233	70p
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BD243A	72p
BD243C	85p
BD244A	82p
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BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BD249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
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BD435	81p
BD436	81p
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BD442	93p
BD529	1.20
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BD535	75p
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BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
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BD678	83p
BD711	1.32
BD712	1.32

BDX14	1.30
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BDY58	6.15
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BDY61	2.80
BDY62	2.34
BDY92	3.75
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BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFS21A	4.50
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.08
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	30p
BFX30	35p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	35p
BFX85	38p
BFX86	40p
BFX87	32p
BFX88	33p
BFX89	1.08
BFY18	1.15
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	25p
BFY51	25p
BFY52	25p
BFY53	45p
BFY56	70p
BFY56A	65p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY80	95p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00

BSX19	25p
BSX20	25p
BSX21	40p
BSX26	60p
BSX27	78p
BSX28	66p
BSX29	60p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	3.00
BU105	1.70
BU109	3.00
BU126	1.66
BU204	2.25
BU205	1.75
BU206	2.00
BU208	2.00
BU326S	2.25
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.80
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	4.50
BUX20	17.00
D40NI	1.50
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.40
MJ420	1.80
MJ430	1.27
MJ440	1.00
MJ481	2.79
MJ491	3.64
MJ802	4.46
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	3.50
MJ2501	3.70
MJ2955	1.00
MJ3000	3.30
MJ3001	3.50
MJ3701	2.55
MF4502	4.46
MJE340	55p
MJE370	72p
MJE371	79p
MJE520	58p
MJE521	71p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	1.00
MJE3055	75p
MJE3739	4.58
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	45p
MPF103	40p
MPF104	40p
MPF105	40p
MPF112	50p
MPF121	1.21
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	20p
MPSA06	22p
MPSA10	20p
MPSA12	28p
MPSA13	28p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	50p
MPSA43	50p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	65p
MPSA93	66p

MPSL01, MPSL51, MPSU01, MPSU04, MPSU05, MPSU06, MPSU07, MPSU51, MSPU55, MPSU56, MPSU57, MRF421, MFR450A, MRF453, MRF454, MRF475, MRF477, MRF479, MRF604, NKT124, NKT125, NKT126, NKT128, NKT129, NKT135, NKT137, NKT210, NKT215, NKT216, NKT218, NKT219, NKT224, NKT225, NKT229, NKT238, NKT239, NKT240, NKT241, NKT242, NKT243, NKT243, NKT244, NKT254, NKT261, NKT262, NKT271, NKT272, NKT275, NKT281, NKT404, NKT405, NKT406, NKT453, NKT603F, NKT613F, NKT674F, NKT677F, NKT713, NKT717, NKT734, NKT736, NKT773, NKT781, NKT12329, NKT12429, NKT13329, NKT13429, NKT16229, NKT20329, OC20, OC22, OC23, OC25, OC28, OC29, OC35, OC41, OC43, OC44, OC70, OC71, OC72, OC82, OC82D, OC83, P346A, R2008B, R2010B, SC107, SC108, SC109, TIP29A, TIP29C, TIP30A, TIP30C, TIP31A, TIP31C, TIP32A, TIP32C, TIP35C, TIP36A, TIP36C, TIP41A, TIP41C, TIP42A, TIP42C, TIP49, TIP50, TIP53, TIP54, TIP110, TIP112, TIP115, TIP117, TIP120, TIP123, TIP125, TIP127, TIP130, TIP132, TIP135, TIP137, TIP140, TIP142, TIP145, TIP147, TIP2955, TIP3055, TIS37, TIS43, TIS45, TIS46, TIS47, TIS48, TIS49, TIS50, TIS51, TIS52, TIS53, TIS54, TIS55, TIS58, TIS60, TIS62, TIS64

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TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

DIACS

[illegible]100	40p
[illegible]2	29p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
[illegible]101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
C44	35p
C47	50p

4, 8 & 12 Amps
Texas to 220
Suffix: A = 100V
B = 200V,
C = 300V
D = 400V
M = 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p
TIC106D	59p
TIC106M	68p
TIC116A	66p
TIC116B	68p
TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p
TIC126C	73p
TIC126D	77p
TIC126M	95p

SIEMENS THRISTORS
[illegible] amp plastic

[illegible]30106 (100V)	60p
[illegible]30113 (200V)	70p
[illegible]30146 (700V)	1.12

[illegible] amp plastic

[illegible]30206 (100V)	80p
[illegible]30213 (200V)	1.10
[illegible]30246 (700V)	2.00

[illegible] Thyristors

[illegible]	1.80
[illegible]-500R	1.40
[illegible]	1.50
[illegible] Use [illegible]M	
[illegible]	1.70
[illegible]	1.50
[illegible]	1.30

TRIACS
Texas 400V
[illegible] Case

[illegible](4A)	66p
[illegible](6A)	74p
[illegible](8A)	88p
[illegible](12A)	1.16
[illegible](16A)	1.22
[illegible](20A)	1.90
[illegible](25A)	2.11

Other Triacs

[illegible] (TO5)	1.44
[illegible] (TO127)	3.39
[illegible] (Quadrac)	2.23
[illegible] (TO5)	1.65
[illegible]	2.70
[illegible] (TO66)	3.33
[illegible]	1.92

DIODES

[illegible]	30p
[illegible]	70p
[illegible]	92p
[illegible]	08p
[illegible]	10p
[illegible]	1.47
[illegible]	1.75
[illegible]	1.65
[illegible]	1.80

1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85
1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	5p
1N4003	6p
1N4004	7p
1N4005	8p
1N4006	9p
1N4007	10p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5402	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA118	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	200p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

BRIDGE RECTIFIERS
(PIV shown in brackets)
1 amp type

W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietory Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES
400-500mW
E24 Series

2.4-47V	10p

1.3 Watt
E24 Series

3.3-82V	20p

2.5 Watt
E24 Series

7.5-75V	1.10

5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.25

10W Pos. Stud
Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25

20W Pos. Stud
(BZY93 series)
E24 values
7V5-75V 2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	4.74
BPX29	4.74
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	10p
LD36A	12p
LD37A	12p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2.65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2.25
TIL66	2.30
TIL67	2.35
TIL78	60p
TIL81	1.60
TIL99	1.35
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.15
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES
To be brought into stock please phone

THERMISTORS

VA1010	40p
VA1026	40p
VA1033	40p
VA1034	40p
VA1035	40p
VA1037	40p
VA1039	40p
VA1040	40p
VA1053	40p
VA1055	40p
VA1056	40p
VA1065	40p
VA1067	40p
VA1074	40p
VA1086	40p
VA1091	40p
VA1098	40p
VA1100	40p
VA1103	40p
VA1104	90p
VA1108	40p
VA1109	40p
VA1110	40p
VA1191	40p
VA3705	4.15
GD25	1.25

Many other Thermistors in stock please phone

VOLTAGE DEPENDANT RESISTORS (VDRs)

E298ZZ05	35p
E298ZZ06	35p
E299DDP116	40p
E299DDP118	40p
E299DDP120	40p
E299DPP216	40p
E299DDP218	40p
E299DDP220	40p
E299DDP224	40p
E299DDP226	40p
E299DDP228	40p
E299DDP230	40p
E299DDP232	40p
E299DDP234	40p
E299DDP236	40p
E299DDP238	40p
E298EDA258	40p
E298EDA260	40p
E298EDA262	40p
E298EDA265	40p
E298EDA268	40p
E299DDP336	40p
E299DDP338	40p
E299DDP340	40p
E299DDP342	40p
E299DDP344	40p
E299DDP346	40p
E299DDP348	40p
E299DDP350	40p
E299DDP352	40p
E299DPP354	40p

LINEAR ICs

AN103	2.20
AY1-0212	6.60
AY1-1313	6.90
AY1-1320	3.20
AY1-5050	1.40
AY1-1270	8.70
AY3-8910	7.20
AY3-8912	6.80
AY5-2376	10.50
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA3028A	1.21
CVA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.10
CA3048	2.99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	1.95
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	1.00
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3088E	2.35
CA3089E	1.95
CA3099E	2.80
CA3130E	90p
CA3130T	1.80
CA3140E	50p
CA3140T	85p
HA1366W	5.50
HA1388	3.00
ICL7106	7.50
ICL7107	9.60
ICL8038	3.20
ICM7555	90p
LC7120	6.15
LC7130	4.95
LF351	47p
LF353	1.03
LF355	83p
LF356	87p
LF357	87p
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	3.90
LM11CH	4.50
LM114	5.90
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM317T	1.50
LM318H	2.40
LM318N	2.00
LM319H	2.48
LM319N	2.10
LM320 — See 79XX Series Volt. Regulators	
LM324N	50p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	51p
LM340 — See 78XX Series Volt. Regulators	
LM345K	3.60
LM348N	70p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.55
LM378N	3.40
LM379S	5.60
LM380N14	75p
LM380N8	75p
LM381AN	2.26
LM381N	1.40
LM382N	1.25
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	1.32
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	80p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.30
LM733CN	77p
LM741CH	96p
LM741CN	20p
LM741CN14	80p
LM747CN	70p
LM748CH	1.00
LM748CN	39p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.27⅔
LM1458	48p
LM1496	1.08
LM1800	3.24
LM1801	3.47
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.75
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.75
LM1872	4.75
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.60
LM2917N	1.95
LM2917N8	1.90
LM3254	6.77
LM3301	1.60
LM3302	95p
LM3401	95p
LM3403	85p
LM3405	1.65
LM3900	48p
LM3905	1.25
LM3909	70p
LM3911	1.68
LM3914	2.25
LM3915	2.25
LM3916	2.25
LM4250CH	2.63
LM4250N	2.39
LM13600	1.25
MB3712	2.36
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303 = LM1303N	
MC1304 = LM1304N	
MC1305 = LM1305N	
MC1307 = LM1307N	
MC1310 = LM1310N	
MC1330 = LM1330N	
MC1352	1.75
MC1456	1.80
MC1458 = LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496 = LM1496	
MC3340	1.45
MC3401 = LM3401	
MC3403 = LM3403	
MC3405 = LM3405	
NE531N	1.50
NE543N	2.50
NE544N	1.80
NE555	20p
NE556	57p
NE558	1.43
NE560	4.99
NE562	5.13
NE565	1.25
NE566	1.65
NE567	1.37
NE570	4.40
NE571	4.20
NE5534A	2.50
PLL02A	5.32
PLL03A	12.75
RC4136	75p
A566B	2.66
SAD1024A	12.95
SAS560	1.65
SAS570	1.65
SAS580	2.20
SAS590	2.20
SFF96364	8.28
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN7600N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
AN76013N	1.95
SN76023N = SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	1.70
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7120	2.20
TA7204	2.75
TA7205	2.20
TA7222	2.30
TA7310	2.00
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	75p
TBA331	1.50
TBA341	2.05
TBA395	1.65
BTA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.89
TBA550	3.51
TBA550Q	3.62
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
BTA641BX1	3.00
TBA651	90p
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	83p
TBA810	1.00
TBA820M	75p
TBA920	2.70
TBA920Q	2.82
TBA950	3.00
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TCA800Q	3.60
TCA830S	1.90
TCA900	2.00
TCA940	2.25
TDA1002	3.00
TDA1003	3.60
TDA1004	3.00
TDA1005	3.60
TDA1010A	2.59
TDA1022	5.60
TDA1024	1.00
TDA1034	3.20
TDA2002	3.39
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	1.10
TL071	36p
TL430	1.71
UAA170	1.97
UAA180	1.97
ULN2003	1.25
UPC575C2	4.00
UPC1156	3.20
XR2206	3.00
ZN414	1.00
ZN419	2.25
ZN1034	2.00
ZN1040	7.75
ZTK22	89p
ZTK33	89p

TTL

7499	11p
7401	11p
7402	11p
7403	13p
7404	12p
7405	18p
7406	25p
7407	25p
7408	16p
7409	16p
7410	15p
7411	21p
7412	21p
7413	25p
7414	33p
7416	25p
7417	22p
7420	15p
7421	22p
7422	20p
7423	25p
7425	26p
7426	30p
7427	25p
7428	28p
7430	15p
7432	30p
7433	30p
7437	26p
7438	26p
7440	15p
7441	65p
7442	38p
7443	80p
7444	80p
7445	60p
7446	55p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	31p
7473	30p
7474	23p
7475	38p
7476	28p
7480	44p
7481	1.08
7482	68p
7483	46p
7484	79p
7485	90p
7486	26p
7489	2.20
7490	28p
7491	45p
7492	30p
7493	30p
7494	49p
7495	55p
7496	45p
7497	1.28
74100	85p
74104	54p
74105	38p
74107	30p
74109	32p
74110	40p
74116	95p
74118	75p
74119	98p
74120	70p
74121	30p
74122	45p
74123	46p
74125	40p
74126	41p
74128	40p
74132	40p
74136	40p
74141	70p
74142	1.99
74143	2.48
74144	2.55
74145	68p
74147	1.10
74148	75p
74150	80p
74151	46p
74153	48p
74154	72p
74155	50p
74156	50p
74157	50p
74159	1.00
74160	62p
74161	62p
74162	62p
74163	62p
74164	65p
74165	62p
74166	69p
74170	1.60
74172	3.08
74173	76p
74174	75p
74175	75p
74176	75p
74177	75p
74178	1.00
74180	60p
74181	1.60
74182	90p
74184	90p
74185	1.20
74186	4.95
74188	3.30
74190	72p
74191	72p
74192	72p
74193	72p
74194	72p
74195	63p
74196	63p
74197	63p
74198	1.00
74199	1.00
74221	77p

74LS TTL

74LS01	14p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	15p
74LS08	15p
74LS10	15p
74LS11	15p
74LS12	15p
74LS13	15p
74LS14	48p
74LS15	15p
74LS20	20p
74LS21	15p
74LS22	20p
74LS27	18p
74LS28	22p
74LS30	17p
74LS32	16p
74LS33	16p
74LS37	16p
74LS38	16p
74LS40	25p
74LS42	39p
74LS47	40p
74LS51	16p
74LS54	22p
74LS55	18p
74LS73	25p
74LS74	20p
74LS75	30p
74LS76	30p
74LS78	30p
74LS80	1.20
74LS83	50p
74LS85	80p
74LS86	24p
74LS90	35p
74LS92	38p
74LS93	35p
74LS95	1.00
74LS96	1.00
74LS107	45p
74LS109	29p
74LS112	33p
74LS113	31p
74LS114	31p
74LS122	41p
74LS123	50p
74LS124	1.20
74LS125	30p
74LS126	31p
74LS132	46p
74LS136	29p
74LS138	36p
74LS139	36p
74LS145	75p
74LS147	1.62
74LS148	90p
74LS151	35p
74LS153	60p
74LS154	1.99
74LS155	40p
74LS156	40p
74LS157	35p
74LS158	36p
74LS160	41p
74LS161	44p
74LS162	44p
74LS163	44p
74LS164	49p
74LS165	1.00
74LS168	2.56
74LS169	2.42
74LS170	90p
74LS173	71p
74LS174	59p
74LS175	52p
74LS181	1.40
74LS183	3.25
74LS190	51p
74LS191	48p
74LS192	51p
74LS193	59p
74LS194	45p
74LS195	52p
74LS196	58p
74LS197	66p
74LS221	65p
74LS240	81p
74LS241	92p
74LS242	80p
74LS243	80p
74LS244	85p
74LS245	90p
74LS247	1.00
74LS248	65p
74LS249	67p
74LS251	40p
74LS253	40p
74LS257	46p
74LS258	46p
74LS259	95p
74LS261	2.30
74LS266	29p
74LS273	90p
74LS275	3.22
74LS279	55p
74LS280	2.80
74LS283	1.59
74LS289	4.70
74LS290	65p
74LS293	50p
74LS295	2.25
74LS298	1.59
74LS299	4.56
74LS323	3.00
74LS324	2.21
74LS325	3.33
74LS326	3.51
74LS327	3.33
74LS347	1.61
74LS348	1.90
74LS352	1.95
74LS353	1.95
74LS362	9.35
74LS365	36p
74LS366	45p
74LS367	36p
74LS368	51p
74LS373	79p
74LS378	75p
74LS386	33p
74LS390	70p
74LS393	60p
74LS395	2.15
74LS396	1.99
74LS398	2.80
74LS399	2.00
74LS445	1.30
74LS490	3.00
74LS540	1.35
74LS541	1.35
74LS640	2.20
74LS641	2.25
74LS643	2.25
74LS644	2.75
74LS668	2.00
74LS669	2.10
74LS670	1.75
74LS673	5.50
74LS674	7.50

74S TTL

74S00	60p
74S02	60p
74S04	60p
74S08	75p
74S20	60p
74S30	60p
74S32	1.00
74S40	1.45
74S64	60p
74S65	1.45
74S74	1.00
74S85	3.25
74S86	2.05
74S112	90p
74S113	1.00
74S124	3.50
74S132	1.80
74S133	1.00
74S138	2.35
74S139	2.35
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.60
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.75
74S201	4.00
74S225	5.60
74S261	3.00
74S262	10.00
74S287	3.71
74S288	3.71
74S289	2.81
74S301	3.99
74S470	6.75
74S471	6.75
74S473	12.50
74S474	4.25
74S475	13.10
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74C CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	1.20
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	1.15
74C164	1.15
74C165	2.00
74C173	98p
74C174	1.22
74C175	1.00
74C192	1.15
74C193	1.13
74C194	1.20
74C195	1.06
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	15p
4001	16p
4002	15p
4003	60p
4007	17p
4008	62p
4009	37p
4010	39p
4011	15p
4012	18p
4013	30p
4014	58p
4015	60p
4016	27p
4017	48p
4018	60p
4019	32p
4020	60p
4021	65p
4022	64p
4023	19p
4024	38p
4025	19p
4026	1.30
4027	30p
4028	60p
4029	75p
4030	38p
4031	1.95
4032	1.40
4033	1.90
4034	1.61
4035	78p
4036	3.00
4037	1.30
4038	1.22
4040	54p
4041	69p
4042	60p
4043	61p
4044	70p
4045	1.20
4046	68p
4047	68p
4048	50p
4049	29p
4050	29p
4051	55p
4052	68p
4053	58p
4054	1.20
4055	1.18
4056	1.30
4059	5.50
4060	88p
4063	90p
4066	34p
4067	3.90
4068	17p
4069	18p
4070	19p
4071	19p
4072	20p
4073	19p
4075	20p
4076	60p
4077	49p
4078	23p
4081	20p
4082	20p
4085	65p
4086	72p
4089	1.50
4093	38p
4094	1.45
4095	90p
4096	90p
4097	3.20
4098	87p
4099	90p

For higher numbners in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS

4502	80p
4503	50p
4507	39p
4508	1.80
4510	65p
4511	48p
4512	64p
4514	1.49
4515	1.45
4516	75p
4518	47p
4519	43p
4520	68p
4521	1.48
4526	78p
4527	1.10
4528	72p
4532	88p
4534	5.00
4536	3.10
4538	1.20
4539	1.20
4543	1.10
4553	2.90
4555	60p
4556	60p
4560	2.00
4566	1.75
4569	2.20
4584	52p
4585	1.00

COMPUTER ICs
CPUs

1802	7.70
2650A	12.25
6502	4.65
6800	3.95
6802	4.80
6809	10.95
8035	7.44
8060	10.90
8080A	3.75
8085A	5.60
8900	57.75
9980	21.00
SCMP1	17.66
Z80A	4.44

MEMORIES

1702A	5.00
2101	4.00
2102AL2	1.35
2111-1	3.00
2114	1.17
2532	4.69
2708	3.00
2716 (5V)	2.50
4027	3.00
4044	7.00
4060	9.50
4116 (200ns)	98p
4118-3	5.00
4164	8.40
5204	7.50
6116	6.50
6514	3.30
6810	1.99
7489	2.65
74189	4.00
74LS289	4.00
,4S188	3.50
74S287	3.30
74S288	2.50

ZERO INSERTION DIL SOCKETS

24 pin	6.25
40 pin	11.37

LOGIC ICs including COMPUTER SUPPORT

ADC0800	22.50
ADC0816	14.90
ADC0817	10.06
AY5-2376	12.00
ICM7555	90p
INS1671	20.00
INS1771	20.00
INS1791	34.00
MC1466L	6.50
MC1488	75p
MC1489	75p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	8.25
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	10.80
RO2513LC	7.50
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	10.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	4.25
ULN2003A	1.15
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	1.25
81LS96	1.25
81LS97	1.25
81LS98	1.25
6522	5.30
6532	7.85
6821	1.80
6845	10.00
6847	10.00
6850	1.90
6852	4.00
6875	6.30
8131	3.75
8154	9.59
8155	8.00
8212	1.80
8216	1.80
8223	1.80
8224	2.50
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.95
8253	8.00
8254	10.00
8255	3.75
8257	8.00
8259	8.00
8279	9.95
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9602	2.50
Z80ACTC	3.50
Z80ADART	8.00
Z80ADMA	12.00
Z80APIO	3.50
ZN425E8	3.75
ZN426E8	3.75
ZN427E8	6.75
ZN428E8	5.25

VOLTAGE REGULATORS
(See also Linear ICs)
— Positive —

100mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100mA To5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500mA T0202	
7805M	47p
7812M	47p
7815M	47p
7824M	47p
1 Amp T0220	
7805T	50p
7812T	50p
7815T	50p
7824T	50p
1.5 Amp T03	
7805K	1.40
7812K	1.40
7815K	1.40
7824K	1.40

— Negative —

100mA T092	
79L05	70p
79L12	70p
79L15	70p
500mA T0202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp T0220	
7905T	60p
7912T	60p
7915T	60p
7924T	60p
1.5 Amp T03	
7905K	2.20
7912K	2.20
7915K	2.69
7924K	2.69

— Variable —

L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.50
LM317K	3.42
LM317MP	1.64
LM317T	2.00
LM337K	4.60
LM337MP	1.73
LM337T	2.25
LM345K	3.60
LM350K	4.50
LM396K	13.52

DIL SWITCHES
SPST

6 way	85p
8 way	90p
10 way	1.00
Ganged	
2 × 2 pole	65p
4 × 2 pole	1.00
1 × 4 pole	1.20

GRAPHIC PROCESSORS

EF9365	62.00
EF9366	62.00

HEATSINKS CLIP-ON

TO1 (AC128)	18p
TO5 (BFY51)	18p
TO18 (BC109)	18p
TO220 (TIP29)	36p

Many other sinks in stock including power-sinks. Please phone

Rechargeable Batteries:
Guaranteed minimum 500 charges

HP2 (1.2AH)	2.25
HP2 (4AH)	4.99
HP7 (½ AH)	1.10
HP11 (1.2AH)	4.20

Chargers
TYPE H:
Adjustable to 6 of any HP type
Above **£15.59**
TYPE P:
PP3 **£5.50**
TYPE A:
HP7 (Up to 4 at a time) **£5.85**

QUARTZ CRYSTALS
Please enquire about types not listed

32.768KHz	3.00
100KHz	3.00
200KHz	3.50
1.00MHz	3.28
1.008MHz	3.50
2.00MHz	2.50
2.097152MHz	3.50
3.2768MHz	3.00
4.00MHz	3.00
4.194394MHz	3.00
4.433619MHz	1.45
5.00MHz	3.50
6.00MHz	2.75
6.9375MHz	3.50
8.00MHz	2.75
10.00MHz	2.75
18.00MHz	2.75
20.00MHz	3.25
27.648MHz	2.60
48.00MHz	3.00
100.00MHz	5.50
5.5 MHz Ceramic filter	90p

VALVES

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BC307	8p	BC640	23p	40823	65p
BC308	8p	2SC1775A	22p	3SK45	49p
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BC413	10p	2SD666A	30p	3SK60	58p
BC414	11p	2SB646A	30p	3SK88	99p
BC415	10p	2SD668A	30p	MEM680	75p
BC416	11p	2SB648A	40p	BF960	99p
BC546	12p	BF256	38p	BF961	70p
		2SK55	28p	BF963	99p

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CMOS

4000	0.11
4001	0.11
4002	0.12
4007	0.13
4008	0.50
4008AE	0.80
4009	0.25
4010	0.30
4011AE	0.24
4011	0.11
4013	0.25
4015	0.50
4016	0.22
4017	0.40
4019	0.38
4020	0.55
4021	0.55
4022	0.55
4023	0.15
4024	0.33
4025	0.15
4026	1.05
4027	0.26
4028	0.50
4029	0.55
4030	0.35
4035	0.67
4040	0.50
4042	0.50
4043	0.50
4043AE	0.93
4044	0.60
4046	0.60
4047	0.68
4049	0.24
4050	0.24
4051	0.55
4052	0.55
4053	0.55
4054	1.30
4055	1.30
4056	1.30
4059	5.75
4060	0.75
4063	1.15
4066	0.30
4067	4.30
4068	0.16
4069AE	0.14
4070	0.16
4071	0.16
4072	0.16
4073	0.16
4075	0.16
4076	0.55
4077	0.18
4078	0.18
4081	0.12
4082	0.18
4093	0.30
4099	0.80
4175	0.80
4502	0.60
4503	0.50
4506	0.70
4507	0.37
4508	1.50
4510	0.55
4511	0.45
4512	0.55
4514	1.25
4515	1.25
4516	0.60
4518	0.35
4520	0.60
4521	1.30
4522	0.89
4527	0.80
4528	0.65
4529	0.70
4531	0.65
4532	0.80
4534	4.00
4536	2.50
4538	0.85
4539	0.80
4543	0.80
4549	3.50
4553	2.70
4554	1.20
4555	0.35
4556	0.40
4557	2.30
4558	0.80
4559	3.50
4560	2.50
4561	1.00
4562	2.50
4566	1.20
4568	1.45
4569	1.70
4572	0.22
4580	3.25
4581	1.40
4582	0.70
4583	0.80
4584	0.27
4585	0.45
4702	4.50
4703	4.48
4704	4.24
4705	4.24
4706	4.50
4720	4.00
4723	0.95
4724	0.95
4725	2.24
40014	0.54
40085	0.99
40098	0.54
40106	0.69
40160	1.05
40161	1.05
40162	1.05
40163	1.05
40174	1.05
40175	1.05
40192	1.08
40193	1.08
40194	1.08
40195	1.08

TTL N

7400N	0.10
7401N	0.10
7402N	0.20
7403N	0.11
7404N	0.12
7405N	0.12
7406N	0.22
7407N	0.22
7408N	0.15
7409N	0.15
7410N	0.12
7411N	0.18
7412N	0.19
7413N	0.27
7414N	0.51
7416N	0.27
7417N	0.27
7420N	0.13
7421N	0.28
7423N	0.22
7425N	0.22
7426N	0.22
7427N	0.22
7430N	0.13
7432N	0.23
7437N	0.22
7438N	0.22
7440N	0.14
7441N	0.54
7442N	0.42
7443N	0.62
7444N	0.62
7445N	0.62
7446N	0.62
7447N	0.62
7448N	0.56
7450	0.14
7451N	0.14
7453N	0.14
7454N	0.14
7460N	0.14
7470N	0.28
7472N	0.27
7473N	0.28
7474N	0.28
7475N	0.35
7476N	0.30
7480N	0.26
7481N	0.20
7482N	0.75
7485N	0.75
7486N	0.24
7489N	1.05
7490N	0.30
7491N	0.55
7492N	0.35
7493N	0.35
7494N	0.70
7495N	0.60
7496N	0.45
7497N	1.40
74100	1.10
74104	0.62
74105	0.62
74107	0.26
74109N	0.35
74110N	0.54
74111N	0.68
74112N	1.70
74116N	1.98
74118N	0.85
74119N	1.20
74120N	0.95
74121N	0.34
74122N	0.34
74123N	0.40
74125N	0.40
74126N	0.40
74128N	0.65
74132N	0.50
74136N	0.65
74141N	0.45
74142N	1.85
74143N	2.50
74144N	2.50
74145N	0.75
74147N	1.50
74148N	1.09
74150N	0.79
74151N	0.55
74153N	0.55
74154N	0.55
74155N	0.55
74156N	0.55
74157N	0.55
74159N	1.90
74160N	0.55
74161N	0.55
74162N	0.55
74163N	0.55
74164N	0.55
74165N	0.55
74166N	0.70
74167N	1.25
74170N	1.25
74173N	1.10
74174N	0.75
74175N	0.75
74176N	0.75
74177N	0.75
74178N	0.90
74179N	1.35
74180N	0.75
74181N	1.22
74182N	0.70
74184N	1.20
74185N	1.20
74188N	3.00
74190N	0.55
74191N	0.55
74192N	0.55
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74194N	0.55
74195N	0.55
74196N	0.55
74197N	0.55
74198N	0.85
74199N	1.00
74221N	1.00
74246N	1.50
74247N	1.51
74248N	1.89
74249N	0.11
74251N	1.05
74265N	0.66
74273N	2.67
74278N	2.49
74279N	0.89
74283N	1.30
74284N	3.50
74285N	3.50
74290N	1.00
74293N	1.05
74297N	2.36
74298N	1.85
74365N	0.85
74366N	0.85
74367N	0.85
74368N	0.85
74390N	1.85
74393N	1.85
74490N	1.85

74LSN

74LS00N	0.10
74LS01N	0.10
74LS02N	0.11
74LS03N	0.11
74LS04N	0.14
74LS05N	0.13
74LS08N	0.12
74LS09N	0.12
74LS10N	0.12
74LS11N	0.12
74LS12N	0.12
74LS13N	0.20
74LS14N	0.30
74LS15N	0.12
74LS20N	0.12
74LS21N	0.12
74LS22N	0.12
74LS26N	0.14
74LS27N	0.12
74LS28N	0.15
74LS30N	0.12
74LS32N	0.12
74LS33N	0.15
74LS37N	0.15
74LS38N	0.14
74LS40N	0.13
74LS42N	0.30
74LS47N	0.35
74LS48N	0.45
74LS49N	0.55
74LS51N	0.13
74LS54N	0.14
74LS55N	0.14
74LS73N	0.21
74LS74N	0.16
74LS75N	0.22
74LS76N	0.20
74LS78N	0.19
74LS83N	0.40
74LS85N	0.60
74LS86N	0.14
74LS90N	0.32
74LS91N	0.28
74LS92N	0.31
74LS93N	0.31
74LS95N	0.40
74LS96N	1.20
74LS107N	0.25
74LS109N	0.20
74LS112N	0.20
74SL113N	0.20
74LS114N	0.19
74LS122N	0.35
74LS123N	0.35
74LS124N	1.80
74LS125N	0.24
74LS126N	0.24
74LS132N	0.42
74LS133N	0.24
74LS136N	0.20
74LS138N	0.30
74LS139N	0.30
74LS145N	1.20
74LS151N	0.30
74LS153N	0.27
74LS154N	0.99
74LS155N	0.35
74LS156N	0.37
74LS157N	0.30
74LS158N	0.30
74LS160N	0.37
74LS161N	0.37
74LS162N	0.37
74LS163N	0.37
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74LS165N	0.60
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74LS168N	0.70
74LS169N	0.85
74LS170N	0.90
74LS173N	0.60
74LS174N	0.40
74LS175N	0.40
74LS181N	1.05
74LS183N	1.75
74LS189N	1.28
74LS190N	0.45
74LS191N	0.45
74LS192N	0.45
74LS193N	0.42
74LS194N	0.35
74LS195N	0.35
74LS196N	0.55
74LS197N	0.60
74LS200N	3.40
74LS202N	3.45
74LS221N	0.50
74LS240N	0.80
74LS241N	0.80
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74C04	0.20
74C08	0.20
74C10	0.20
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74C30	0.20
74C32	0.20
74C42	0.80
74C48	1.03
74C73	0.50
74C74	0.50
74C76	0.48
74C83	0.98
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74C86	0.26
74C89	2.68
74C90	0.80
74C93	0.80
74C95	0.94
74C107	0.48
74C151	1.52
74C154	2.26
74C157	1.52
74C160	0.80
74C161	0.80
74C162	0.80
74C163	0.80
74C164	0.80
74C165	0.84
74C173	0.72
74C174	0.72
74C175	0.72
74C192	0.80
74C193	0.80
74C195	0.80
74C200	4.52
74C221	1.06
74C901	0.38
74C902	0.38
74C903	0.38
74C904	0.38
74C905	5.64
74C906	0.38
74C907	0.38
74C908	0.84
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SOLID STATE REVERB UNIT

Where have all the spring lines gone? Gone to lesser projects in other magazines, that's where. Meanwhile we present this cheap, simple, but high-quality unit using solid state technology. Design by Charles Blakey.

At last — a reverberation unit which is not a pseudo echo effect and does not suffer from the defects of spring line devices. The unit described below will interface with virtually any preamplified signal and is ideal for direct use with most musical instruments or for incorporating in the 'echo-send' line of mixers. The design has been made possible by a new 3328-stage bucket brigade device having six tapped delays and capable of producing a useful reverberation time of about three seconds.

Sound emitted in an enclosed space will be subjected to both simple and multiple reflections from internal surfaces. Since these surfaces are at varying distances, the time for these reflections to occur and then decay by absorption will vary. The effect is a build-up of sound known as reverberation. When playing a musical instrument in the home, small studio or some other venue, the decay time can be very small coupled with a high absorption loss; the result is a weak sound when compared to recorded music or to live music played in a large hall.

Until now the only low-cost method of simulating acoustic reverberation has been the use of spring lines. These units, however, are prone to vibration, require a high power consumption for effective driving and are prone to producing distorted resonant peaks. Furthermore it is not possible to adjust the reverberation time and in many instances a short reverberation can be very effective. Another option has been available for some years, namely, the use of bucket brigade devices to electronically delay signals. While claims have been made for reverberation effects based on these products, a realistic unit would require at least three dual 512-stage BBDs, such as the Reticon SAD1024A. The cost and complexity of the latter approach puts it beyond the reach of the average constructor.

Beyond The Pail

The reverberation unit utilises the MN3011, which is the latest in a series of bucket brigade devices for audio applications to come from National Panasonic. They are all fabricated in PMOS and for a start you can forget most of what you may have read about the disadvantages of PMOS BBDs. It is a fact that they are somewhat limited in clocking speed (10 kHz to 100 kHz) and also have a limited bandwidth, typically 10 to 12 kHz. The latter, however, is not usually a limitation since the bandwidth is often restricted by the desire for long delay times. What makes the series ideal for audio applications is their low insertion loss, low distortion and excellent signal-to-noise ratio and for the MN3011 the specified values are 0 dB, 0.4% and 76 dB respectively.

The IC is unusual in that it has 12 pins but is the length of a normal 18-pin package; the functional block diagram and pinout for the MN3011 is shown in Fig. 1. As is normal with such devices it requires two power supplies, V_{DD} and V_{GG}; the former may be up to −18 V with respect to ground while V_{GG} should be +1 V higher than V_{DD}. Bucket brigade, or charge coupled, devices are analogue shift registers which operate by sampling the input signal at a rate determined by an external clock. The signal level at the time of sampling is stored on an internal capacitor; this charge is then clocked down a series of capacitors by means of internal switches. The transfer process is accomplished by a dual clock whose outputs are in antiphase and so are alternately opening and closing adjacent switches. It will be apparent that the slower the clock speed the longer the delay. Since the devices operate at high clocking speeds the input signals are faithfully reproduced at the output.

The most interesting feature of the

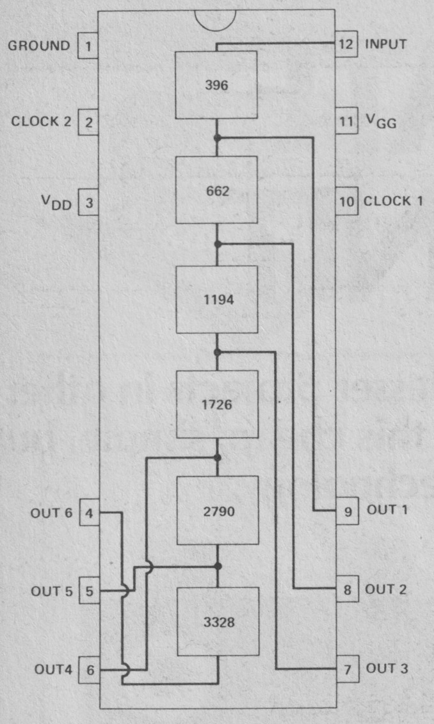


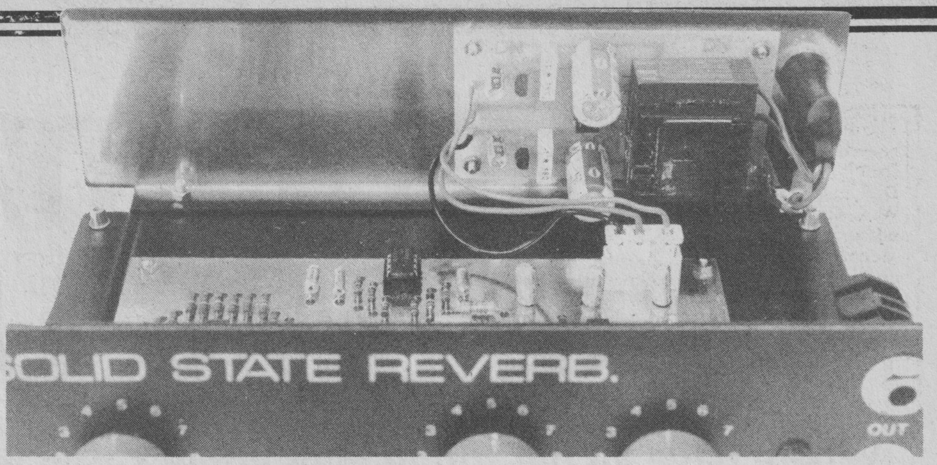
Fig. 1 Pinout and internal layout of the MN3011. The centre three pins on each side of this 18 pin package are absent.

MN3011 is that it has six tapped delays and Fig. 1 shows the number of stages for each tapping. The tappings are not evenly spaced since otherwise the reverberant sound would have a distinct flutter. If the device was being clocked at 10 kHz then the delays from outputs one to six would be 19.8, 33.1, 59.7, 86.3, 139.5 and 166.4 milliseconds respectively. If these delay times are mutiplied by 0.33 then one obtains the equivalent room path length for one trip, ie the longest delay is equal to a room length of 55 metres (181 feet). Reverberation time is usually measured as the time taken for the power to decay to one millionth of its initial level (60 dB down). For the present design the time was measured for the output level to fall to one hundredth of its initial level (−40 dB) and at the longest delay this was found to be about three seconds.

Blocks 'n Clocks

The block diagram of the circuit for the reverberation unit is shown in Fig. 2. First there is the dual clock driver, which is another National Panasonic device, the MN3101. It has an oscillator, divider and wave form shaping and produces the dual clock pulses required by the MN3011. It reduces component count and is lower in cost than other alternatives, such as a 4007. A further advantage is that it also generates the required V_{GG} voltage.

The unit will operate satisfactorily



with any input signal greater than 280 mV RMS and higher input signals are attenuated by the input potentiometer. The signal is also reduced by half in amplifier A1 and inputs higher than 140 mV to the first filter are indicated by a LED peak detector circuit. Although the MN3011 will accept signal levels up to 780 mV before the distortion value stated earlier is exceeded, it will become apparent that the effect of reverberation can lead to reinforcement of signals and consequently this has to be allowed for. The only preset in the circuit is used to apply a bias voltage to the signal. The precise value of this voltage is not very critical in the current design and the object is to keep the signal at a level where it will not be distorted or clipped within the BBD.

The main problem with BBDs is the inability to completely cancel out the clock pulses and these can form audible cross products with the input signal. In order to prevent this foldover distortion, the bandwidth of the input signal should be limited to between a half and a third of the clock frequency. Filter F1 in Fig. 2 is a lowpass filter with a cut-off frequency of 3.6 kHz. This may seem rather low but in fact it is equivalent to the upper reverberation limit of most spring lines and the BBD scores in respect of low frequency responses since springs usually give rise to 'booming' below 100 Hz. The limited bandwidth is compensated by mixing the original signal with the reverberated signal at the output stage. The filtered signal goes to the MN3011 and the six output stages are summed to give a composite signal with different delay times. This signal is again filtered with a lowpass filter with a cut-off frequency of 3.6 kHz, to remove residual clock glitches, prior to mixing with the original signal at the output amplifier, A2.

The most important feature, however, is that the signal from the longest delay is returned, slightly attenuated, to the input and subjected to further delays. This is the reverberation effect and with the times given earlier the sound will simulate the effect of the first reaching a surface 55 metres away (assuming slowest clocking rate) and then being reflected back as well as being reflected from other surfaces closer than the 55 metre surface. The whole process is repeated until the original delayed signal and its reflections die away. In the meantime new signals are being recycled and the overall effect is a build-up of sound — reverberation.

Construction

The construction is very straightforward but the following precautions should be observed. First,

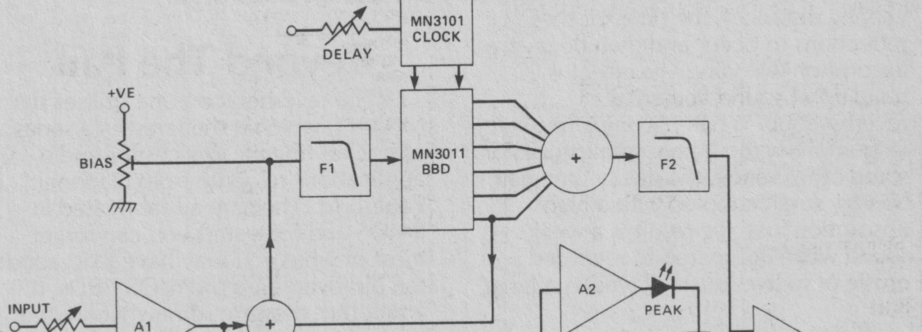


Fig. 2 Block diagram of the ETI Solid State Reverberation unit.

BUYLINES

The PCB and a kit of components for the reverberation unit is available for £32.00, inclusive of postage and VAT, from Digisound Limited, 13 The Brooklands, Wrea Green, Preston, Lancs PR4 2NQ. The power supply may also be obtained for an inclusive price of £7.00. As the PCBs are copyright they will not be available from our PCB Service; however, the foil patterns are reproduced at the back of the magazine. National Panasonic do not distribute active components in the UK and the ICs may *only* be obtained from Digisound.

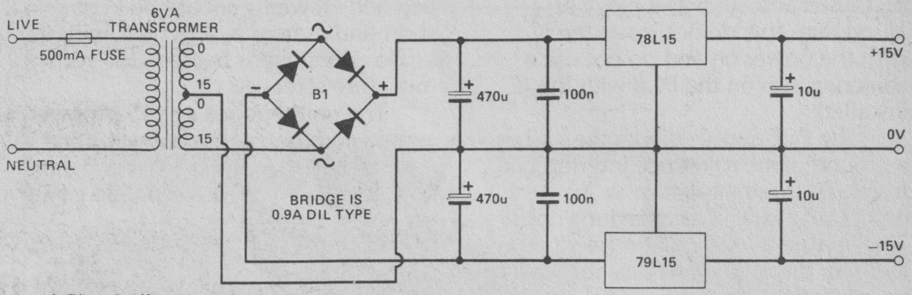


Fig. 4 Circuit diagram of a suitable PSU for this project.

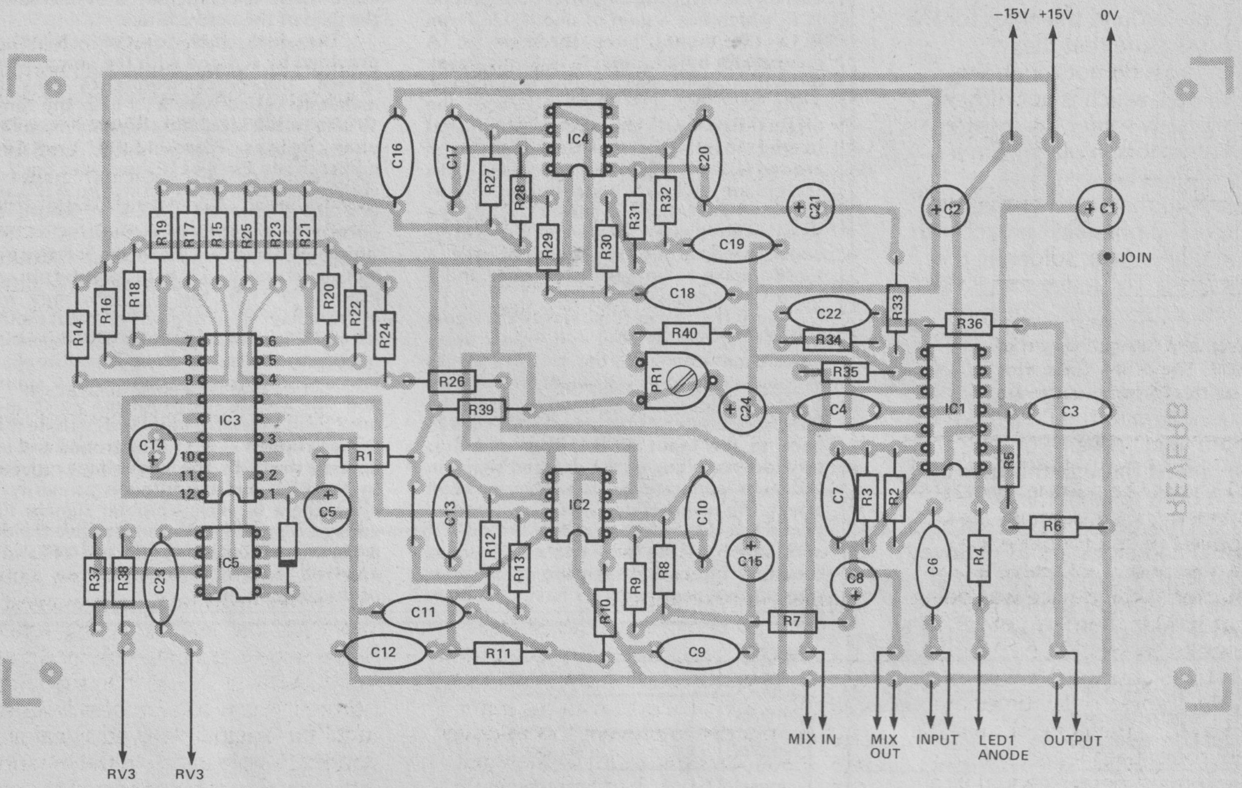


Fig. 3 Component overlay for the reverberation unit.

make sure you get the correct orientation of the ICs which are clearly shown on the component overlay. Second, the MN3011 is a CMOS device and with the advent of 'B' series devices we have all become rather careless as regards handling such ICs. For the MN3011, however, take the precaution of working on a grounded

PSU PARTS LIST

Capacitors

C1,2	470u 35 V PCB electrolytic
C3,4	100n polyester
C5,6	10u 35 V PCB electrolytic

Semiconductors

IC1	78L15
IC2	79L15
BR1	0A9 DIL type

Miscellaneous

PCB (see Buylines); PCB-mounting transformer (15-0-15, 6 VA); 500 mA mains fuse and chassis-mounting holder.

PARTS LIST

Resistors (All ¼ W 5% except where stated)

R1	10R ½W
R2,5,7,9, 13,32,33,39	100k
R3,34	51k
R4	330R
R6	1k3
R8,12,27,31	33k
R10,29,37	47k
R11, 30	56k
R14,16,18,20, 22,24	56k 1%
R15	100k 1%
R17	110k 1%
R19	120k 1%
R21	130k 1%
R23	150k 1%
R25	160k 1%
R26	200k
R28	82k
R35	18k
R36	1k0
R38	36k
R40	68k

Potentiometers

RV1	100k logarithmic
RV2	10k logarithmic
RV3	470k linear

PR1	47k miniature horizontal preset

Capacitors

C1,2	10u 35 V PCB electrolytic
C3,4	100n polyester
C5	22u 35 V PCB electrolytic
C6	220n polyester
C7,10,13, 20,22	220p polystyrene
C8,14,15, 21,24	3u3 63 V PCB electrolytic
C9,11,12, 18,19	2n7 polystyrene
C16	2n2 polystyrene
C17	270p polystyrene
C23	33p polystyrene

Semiconductors

IC1	TL074
IC2, 4	LM358
IC3	MN3011
IC5	MN3101
D1	1N4148
LED1	5 mm red LED

Miscellaneous

SK1,2	mono jack sockets

PCB (see Buylines); IC sockets; case (Vero order no. 91-2673G).

metal surface, such as a piece of aluminium foil, do not insert the IC with the power on and do not use a soldering iron on the PCB with the IC installed.

The PCB supplied with the kit has a ground plane to reduce interference from and to other electronic equipment as well as to reduce noise. This feature allows greater freedom in locating the unit, eg it does not have to be housed in a separate metal case. A ground plane comprises a metallized surface on the component side except for small areas around the holes for the components. Ensure that the component leads do not touch the ground plane — which is not difficult — and preferably solder the resistors and axial capacitors in place with a thin piece of card between the component and the board so that the former are not in physical contact with the ground plane. After soldering the card is removed. Th latter step is not essential. The one wire link must be made with insulated wire. The ground plane has to be connected to the 0 V line and some 15 mm from where the latter is connected to the PCB there is a hole marked 'join'. A piece of wire should be placed through this hole and soldered on both sides of the PCB.

The PCB has been laid out such that the BBD and clock are as far away as practical from the signal input and output. This separation should be maintained if the unit is housed in a box and all wiring should be kept as short and as neat as practical, with the audio connections being made with miniature screened cable.

The unit requires a ±15 V power supply and the current consumption is a miserly 13 mA at +15 V and 9 mA on the −15 V line. If a separate power supply is required then a suitable PSU is shown in Fig. 4. A PCB-mounted transformer is preferred, and it should be mounted as far away from the BBD as practical. The photographs show the unit inside a Vero 'G' range case with internal dimensions of approximately 218 x 138 x 50 mm.

HOW IT WORKS

The input signal is attenuated by RV1 and also by the inverting amplifier built around IC1a which has a gain of about 0.5. From IC1a the signal goes three ways. A comparator built around IC1b forms a peak detector to indicate optimum signal level, while RV2 and R35 allow mixing of the original signal with the reverberated signal in the inverting amplifier configured around IC1c. The component values in this section are such that equal proportions of the two signals may be mixed. Finally the signal also passes to two active filters constructed around IC2 which have a 12 dB/octave roll-off for each stage and a cut-off frequency of 3.6 kHz.

From the above filter stages the signal passes into the MN3011 and the six delay outputs are summed by the resistor network formed by R14 to R25. Note that the shorter the delay, the less the attenuation. From the longest delay (pin 4) the signal goes via R25 back to the input of the filter and thus provides recycling of the delayed signal in order to generate a true reverberation effect. The reverberated signal is filtered by two active filters constructed around IC4 and these have the same characteristics as the input filters. Between the active filter stages some passive filters have also been added to increase the roll-off; the loss in these filters is compensated by increasing the gain of the active filters.

The dual clock for the MN3011 is provided by IC5 and with the components shown, the clock frequency may be manually varied with RV3 over the range 10 kHz to 100 kHz, allowing maximum first pass delays from 16.64 to 166.4 milliseconds. Pin 8 of IC5 provides the V_{GG} voltage for the MN3011. Since both IC3 and IC5 are P-channel CMOS it would be normal to operate them from a −15 V supply. Voltages are, however, relative and by connecting +15 V to the ground pin and ground (0 V) to the V_{DD} pin they will operate happily with positive signal inputs. R1 and C5 prevent clocking signals getting back into the power lines. The filters are also operated from a single +15 V supply and this avoids any problems which may arise from excessive bipolar signals, ie they will be clipped at +15 V or ground and not damage the BBD. The bias voltage required by the BBD and the filters is primarily to allow them to accept bipolar signals; this voltage is provided by the resistive divider using components R39, PR1 and R40 and is applied to the non-inverting input of the filter op-amps.

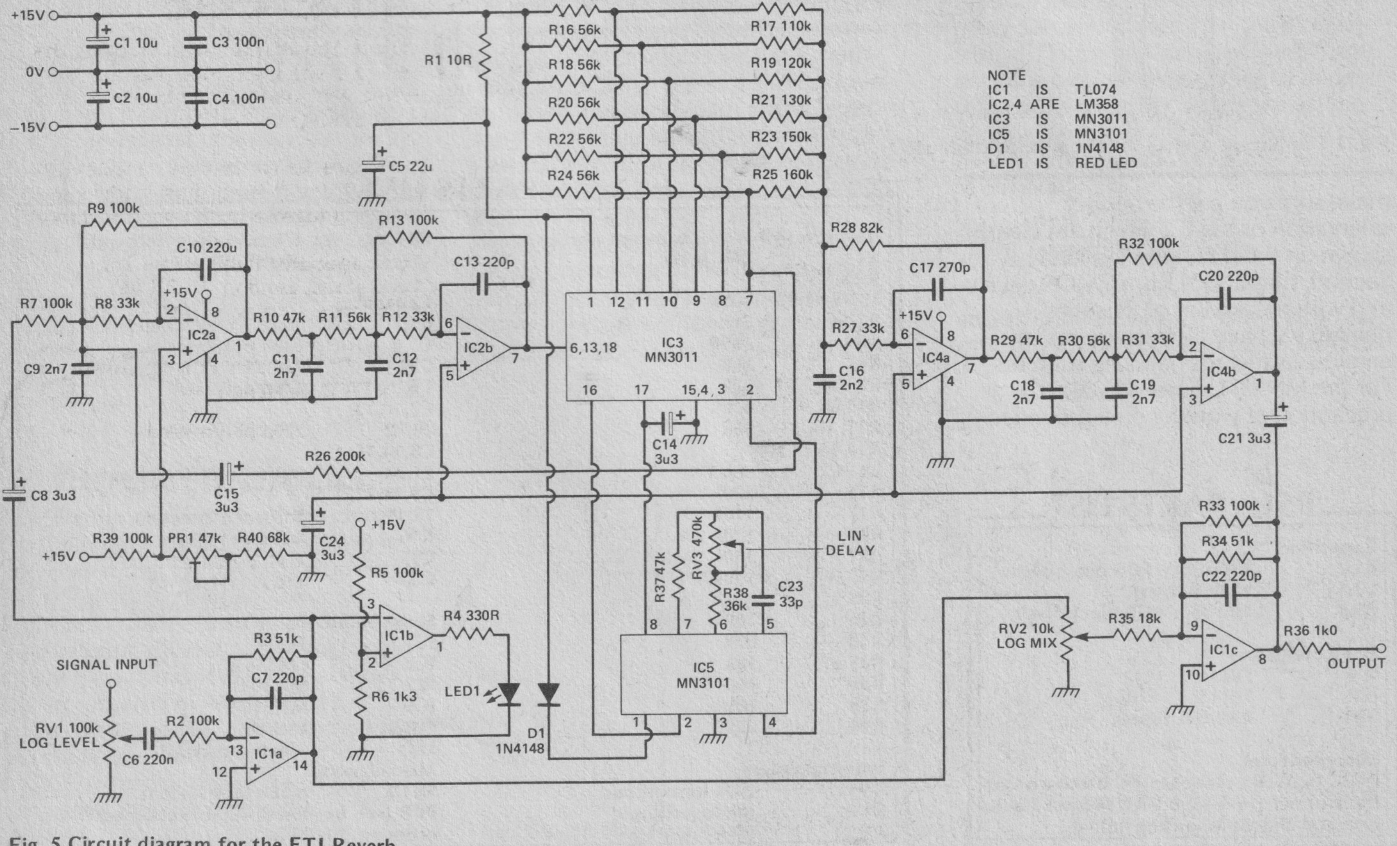
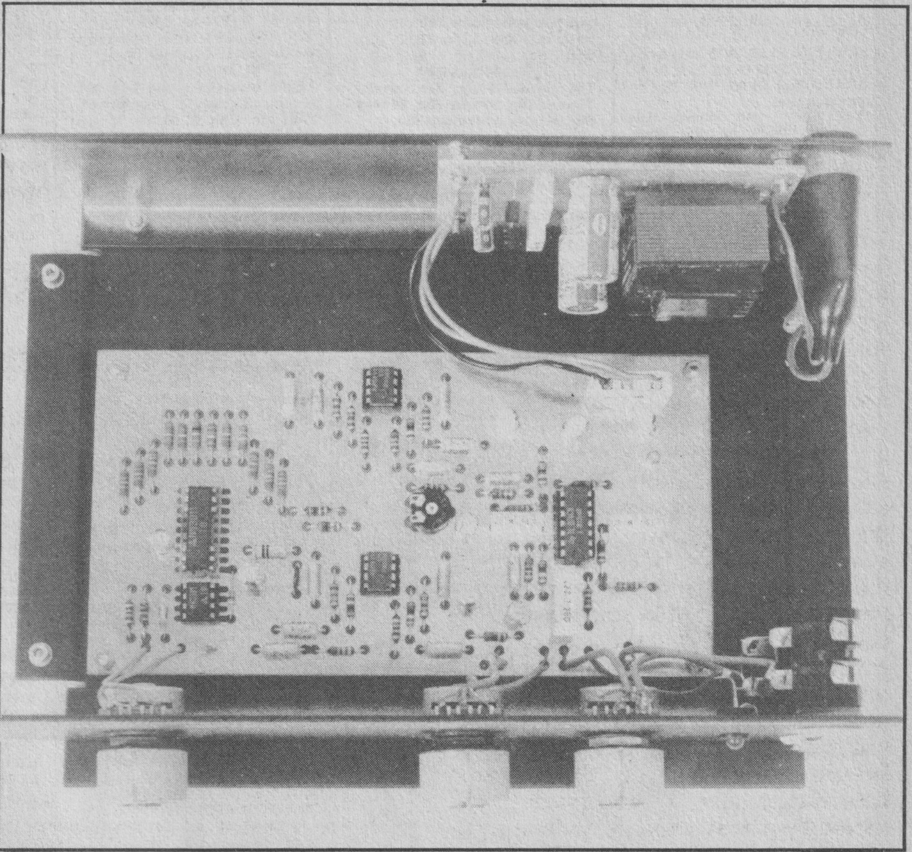


Fig. 5 Circuit diagram for the ETI Reverb.

Setting Up And Use

The only setting up required is adjustment of PR1. If a sinewave source is available then the latter may be used as the signal source and PR1 adjusted by ear, or with an oscilloscope, for minimum distortion. Alternatively measure the voltage at the junction of PR1 and R40 and adjust PR1 to give a reading of 6V2.

The unit has a signal-to-noise ratio of better than 60 dB but this requires that it is operated with the peak indicator LED just glowing or occasionally illuminating. The output level will vary from about 0V5 to 1 V RMS, depending on the amount of mixing of the original signal, and these levels should ensure adequate response from most amplifiers, mixers, and so on. In other words, by keeping input signals at maximum level the amplifier setting will be such that during periods of no signal the residual noise will not be obtrusive. This is common practice with recorders, many of which have much lower signal-to-noise ratios.



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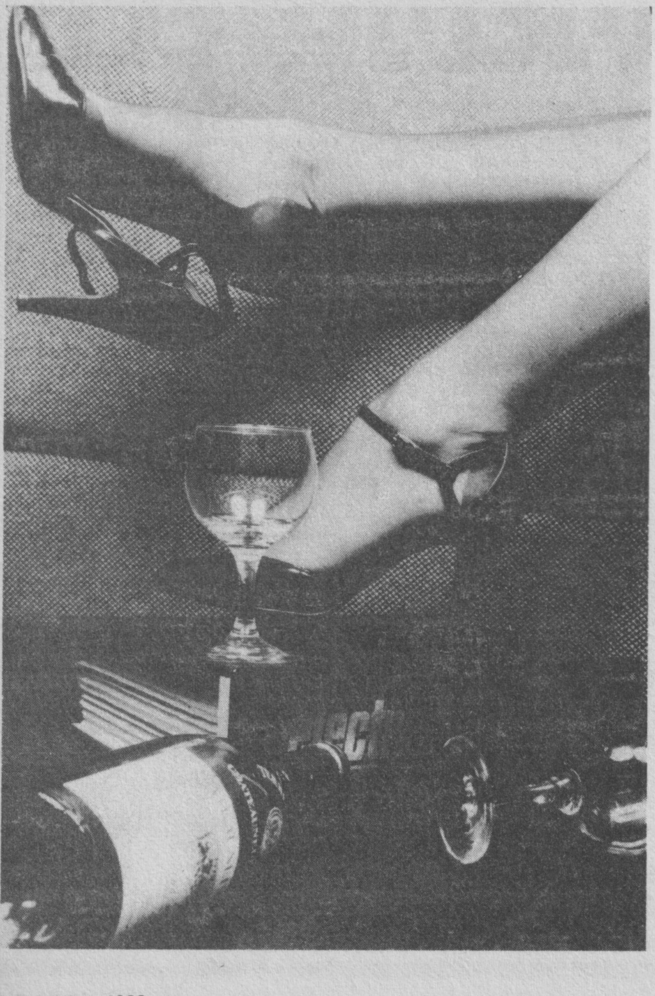

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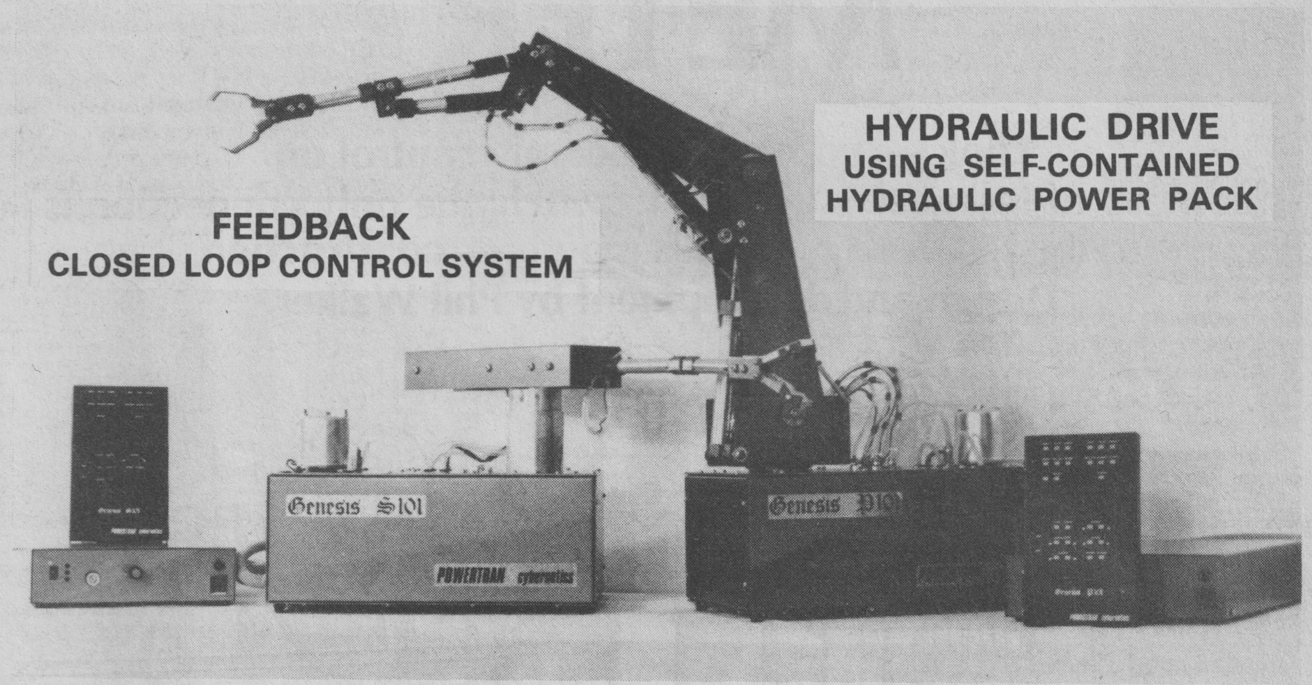

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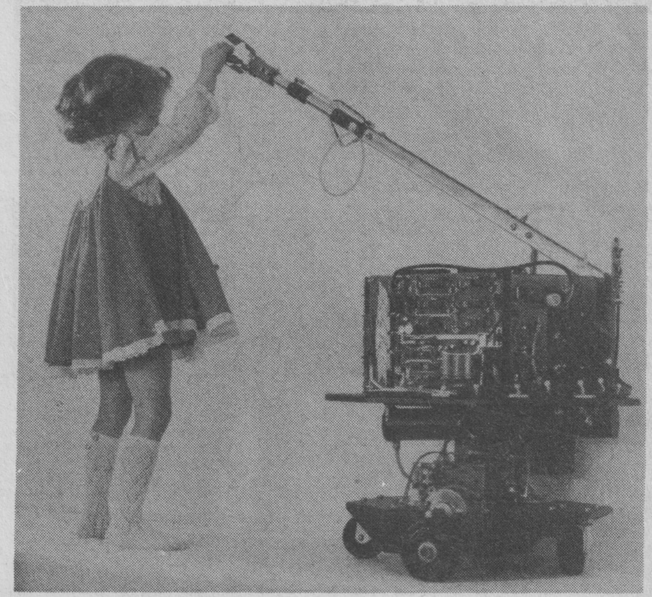

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AUTORANGING CAPACITANCE METER

Look — no hands! The only control on this piece of test-gear is the on/off switch; the only connection is to the test terminals. This month — construction. Design and development by Phil Walker.

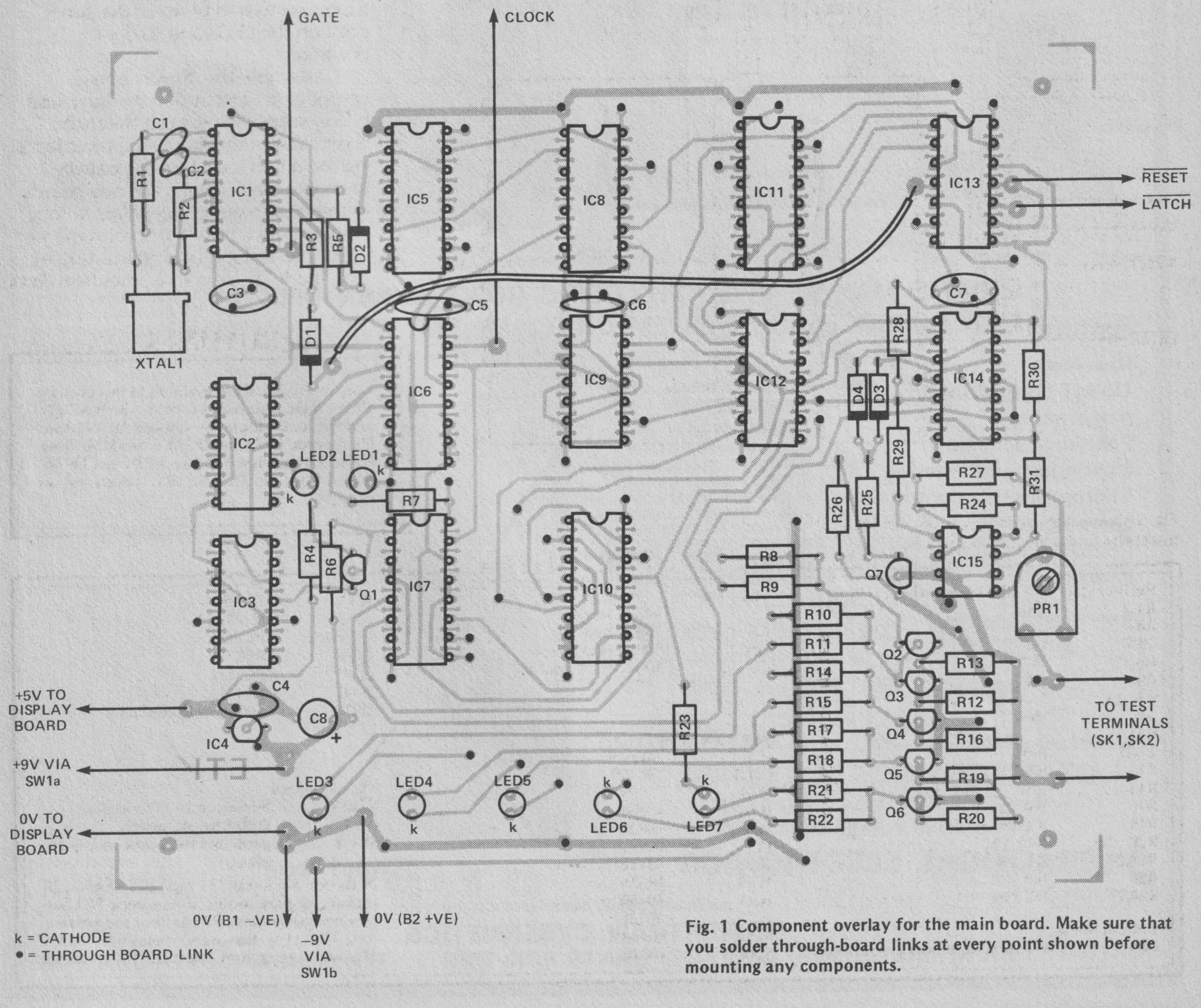
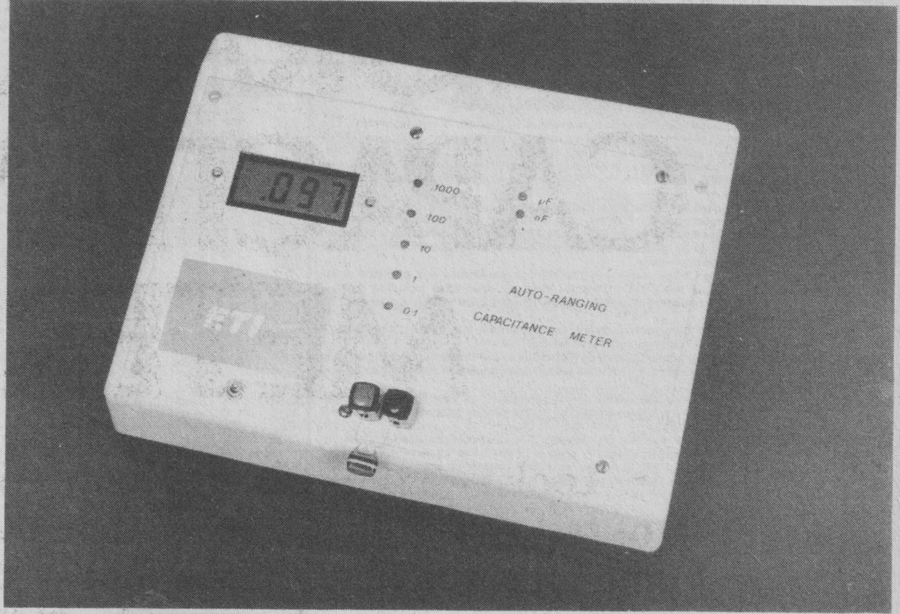


Fig. 1 Component overlay for the main board. Make sure that you solder through-board links at every point shown before mounting any components.

This is a fairly complex project and should only be attempted by those with a good deal of constructional experience. It is well worthwhile checking the PCB for shorts between tracks before doing anything else. Ensure that there is a hole through the board under the PR1 position to facilitate adjustment later.

Put links through the board at all positions marked with a dot on the overlay and solder on BOTH sides of the board. The other components may now be inserted into the board — preferably using sockets for all the ICs except IC4 and IC15. IC4 is a T092-type package 100 mA regulator and does not need a socket, while IC15 may foul PR1 if a socket is used.

The LEDs should not be fitted until the board is test-fitted in position as they are intended to protrude through the panel as indicators. Attach power supply wires and fit up to the panel, position the LEDs and solder in position.



Assemble the display board components and attach the logic and power supply wires from the main board. Wire the remaining power leads via the on/off switch to the battery connectors and attach the two boards to the front panel using pillars or long bolts and lock nuts. Our prototype just fitted into a slope fronted instrument case made by Vero Industries (see Parts List).

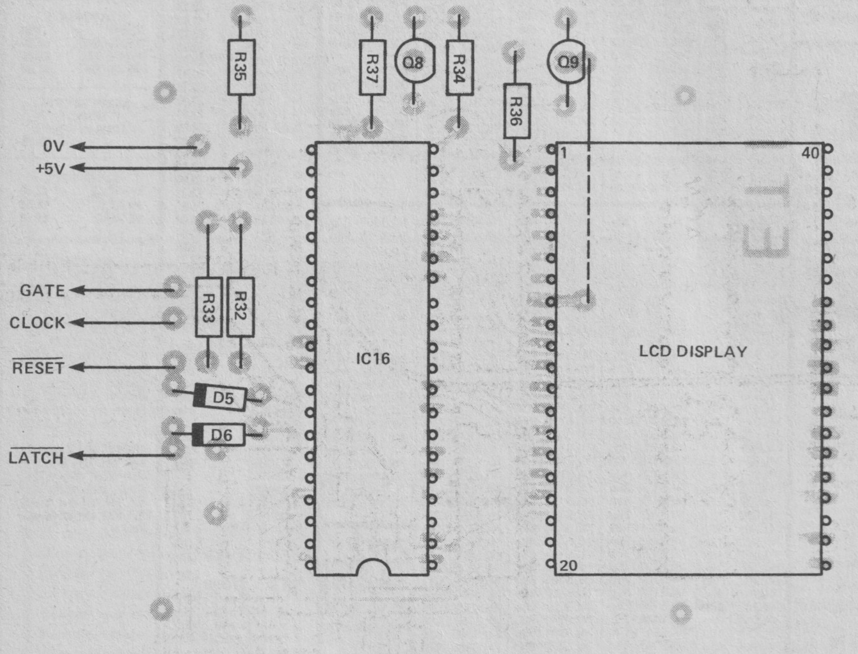


Fig. 2 Component overlay for the display board. Insert the link under the display first.

BUYLINES

Very few unusual components in this project; all the logic is standard CMOS. The ICM7224 and the LCD display is stocked by Watford Electronics, while the LF353 is available from Rapid Electronics. The two PCBs can be obtained from our PCB Service, advertised on page 44.

PARTS LIST

Resistors (all ¼W, 5% except where stated)

R1,2	470R
R3,4,5, 28-37	15k
R6,25	4k7
R9	10k
R10,14,17, 21	100k
R11,15,18, 22,23	1k0
R12	100R 1%
R13	1M0 5% or better
R16	1k0 1%
R19	10k 1%
R20	100k 1%
R24,27	27k 2%
R26	1k8
R24,27	27k 2%

Potentiometer

PR1	47k miniature horizontal preset

Capacitors

C1	10p ceramic
C2	1n0 ceramic
C3-7	100n ceramic
C8	100u 10 V tantalum

Semiconductors

IC1	74LS04
IC2,3	74LS90
IC4	78L05
IC5,8	4518B
IC6	4053B
IC7	4029B
IC9	4013B
IC10	4051B
IC11	4049B
IC12	4012B
IC13	4011B
IC14	4001B
IC15	LF353
IC16	ICM7224
Q1,7,8,9,	BC182L
Q2-6	BC212L
Q3-7	BC212L
D1-6	1N4148
LED1-7	miniature green LEDs

Miscellaneous

XTAL1	miniature 10 MHz crystal
SW1	DPDT toggle switch
SK1,2	press terminals (one red, one black)

PCBs (see Buylines); 3½ digit LCD display; IC sockets; display socket (if required); PP9 battery and connectors; PP3 battery and connectors; mounting hardware; case (Vero 220 x 156 mm sloping front box, order no. 65-2523E).

ETI

Greenbank

Greenbank Electronics
(Dept T4E), 92 Chester Road, New Ferry
Wirral, Merseyside L62 5AG
(Tel. 051 645 3391)

TERMS, VAT. CWO. Cheques etc payable to Greenbank Electronics and crossed. Add VAT to all prices at 15% except where stated otherwise. Post etc: UK 40p (+6p VAT = 46p) per order. Export: NO VAT but add 40p (Eire). £1 (Europe) and £3.50 elsewhere. Access. Barclaycard. Visa. telephoned orders accepted. (Polys. universities. govt depts. etc can telephone their orders for immediate despatch on account.)

BARCLAYCARD welcome here

Offered as an alternative to the well established International Size Computer Cards.

EUROCARD Z80 COMPUTER BOARDS, CUSTOM 80 SYSTEM

The Custom 80 System has been designed as a fully expandable modular computer system. The circuits are supplied as a full kit of parts, all you need are tools and solder.

The colour VDU card gives a teletext format, 24 lines of 40 characters, upper case, lower case, pixel graphics, contiguons, non contiguons, single height, double height, memory mapped etc. The kit is supplied with all the components for colour and is used with your own colour or monochrome T.V. set.

The keyboard Port card is used to interface the ASCII keyboard to the computer. It is interrupt driven giving fast response to keystrokes. On this card is included 1K of user RAM (this is in addition to the 1K of VDU text RAM) and space for a 2K EPROM such as the CSYS operating system. The ROM and RAM can be switched by software, which is desirable if full use if to be made of the dynamic RAM expansion cards.

The CPU board uses the high speed version of the Z80 microprocessor and operates at full 4MHz. Full use can be made of the Z80A's powerful interrupt structures, including mode 2 (vectored) interrupts. The CPU can insert wait states when requested and utilises pulsed reset for use with dynamic RAM's.

For a full 64K system two RAM expansion cards are required. (These may be purchased singly if required. For example if 32K is sufficient for your initial needs).

The microcomputer cards plug into the Custom 80 Micro Bus circuit board which is mounted in the high quality Custom 80 rack, which is in turn fitted with a case conversion kit or a good looking instrument case.

For high speed machine code work the CSYS operating system has been designed to allow maximum use to be made by the user's own programs, of the various subroutines and utilities contained in the firmware.

Programs can be stored using named files on cassette. The dual cassette interface includes facilities for an RS232 or 20 mA. current loop to drive a printer. The band rate is software selectable between 300 and 2400 band. The card also has a Z80A counter timer circuit.

For users who would prefer to write programs in BASIC there is a 4K integer BASIC supplied on cassette tape. It includes commands for setting colour, black and white, graphics etc. PLOT (a point), draw (a line), erase (a line) etc. A 12K Custom 80 BASIC is in development and this will be produced in both interpreting and compiling versions.

Also in development is an interface to floppy disks (and disk operating systems).

If you are working on a tight budget, the various kits of parts can be purchased one at a time, prices range from £34.09 (for the Micro Bus kit with 5 connectors) or £43.22 (for the CPU kit) up to £74.55 (for the colour VDU kit.)

Send for more details (a large SAE is not essential but helps us) and a comprehensive Custom 80 price list.

NEW RELEASE

We are now able to sell the bare PCB's without the components but including full documentation. Custom 80 CPU £18.83, Custom 80 KBP £19.39, Custom 80 Micro Bus £13.87, Custom 80 32K RAM £21.25, Custom 80 VDU £23.70. Ask us for details of Bare Boards for Custom 80 System.

TEX MICROSYSTEMS "EPROMPT" UV ERASER

A low-cost alternative to the above erasers (UV 140/141) claimed by the manufacturer to erase up to 32 chips in 15-30 mins. This is the cheapest eraser we have seen. The unit has no timer, power switch or safety interlock switch. The user places up to 32 chips into loose conducting foam in the erasure tray (16 along the base, 8 on each side). The chips are held in place by the UV tube which sits in the tray. (Unlike the UV 140/141, no s precautions have been taken to prevent the seepage of UV light, but the manufa state that "Incident light from this device is quite safe at distances above 12 inches

(Dimensions – 325 × 64 × 38mm)
EPROMPT ERASER Price £33

MODULAR COMPUTER SYSTEM CARDS

International cards (mostly Kemitron)

A range of 'International' (114 × 203mm) size cards which may be purchased individually as desired or to build up a complete system. Further details available on request. All boards are epoxy glass with gold plated edge plug.

New bare-board prices.

MZB-3 Z80 CPU	£11.50
SCMP-2 SC/MP CPU	£11.50
MPA-7 Buffered SC/MP CPU	£10.75
MXD-2 16K of 4116	£11.50
MXA-1 2K of 2102	£11.50
MXA-3 8K of 2114	£11.50
PRM-8 8K of 2708	£10.75
IP-2 Input Port	£11.50
OP-3 Output Port	£11.50
S10-4 RS232 (two)	£11.50
PP-2 Prom Programmer	£11.50
TPA-2 SC/MP Tape Interface	£10.75
DCR-6 SC/MP Keyboard Interface	£10.75
VDU-A	£10.75
VDU-B	£10.75
VDU-G	£10.75

New boards expected soon.

VDU-K (single board VDU 32x24	£15.95
MP-87 (8070 CPU)	£15.95
MZB-4 (Z80A CPU)	£33.50
MXD-6 (256K Dynamic Ram)	£33.50
DC-2 (S.D. Disk Controller)	£15.95
DC-4 (D.D. Disk Controller)	£33.50
HDA-1 (Hard Disk Adaptor)	£33.50
SOFTWARE	
ZYMON 1 Monitor (2K)	£14.95
BCS BASIC (6K)	£16.95

SWITCH MODE PSUs

AC 5221S 5V/10A	£69.90
AC 5421S 5V/20A	£99.20
AC 9421S 5V/10A 12V/2A 12V/2A 5V/0.1A	£126.50

OPEN CARD SWITCH MODE PSU

FULLY ASSEMBLED P.C.B. CARD 197 × 108 52mm Outputs +5V/6A, 5V/5A, 12V/1A, 12V/1A
Type AC9251 .... £61.75
AC8353 5V/3A, 24V/3A, 12V/0.17A, 187 × 157 × 52mm £69.50

NEW Eurocard Switch Mode PSU's

Fully Assembled Card, 100 × 160mm × 7E 30W output power
Type 7150 +5V at 6A adjustable to +15V at 2A £41.40
Type 7151 +5V at 3A, +12V at 1.2A £42.10

UV 141, UV ERASER

Two easy-to-use units designed for both the professional and amateur UV-prom user.

Features:

- Can erase up to 14 proms
- Special shortwave ultra-violet tube
- Erase time variable between 5 and 50 minutes in 5-minute steps (preventing over exposure which may shorten prom life)
- Sliding tray carries proms on conductive foam
- Safety interlock switch prevents the timing circuit from operating and switching on the tube with the tray open
- "Mains On" and "Tube On" indicators.
- Smart textured case
- Complete instructions supplied

Supplied complete with mains plug and flex

Model UV 141 - Price £77.70
Also available without timer as
Model UV 140 - Price £61.20

Z80 DATA PACK

Comprehensive information on the Z80, CPU, P10, CTC etc., in the bound data books described below.

Mostek Z80 Programming Manual (approx 300 pages) fully detailed explanation of all the Z80 op-codes/assembly language.

Mostek Z80 Microcomputer Data Book (approx 475 pages) contains Z80 instruction set and technical information and specifications of the Z80 family I.C.'s

Mostek Micromputer Systems Data Book (approx 220 pages) contains details of the Mostek range of microcomputer circuit boards and software etc.

The weight of the data pack is approximately 1.9 kilos.

Price: £14.95 (There is no VAT on this item, but please add an extra £1.00 towards the cost of the postage).

T.V. MONITOR P.C.B. for OEM users

This is an assembled P.C.B. size 130 x 190mm. which you add to your own 12" 14" black and white C.R.T. (90 degree. 20mm dia. neck). to obtain a T.V. monitor at modest cost. (Regrettably we cannot supply the C.R.T. at present.)
Preset controls. contrast. brightness. etc.. are included. and the only inputs needed are 15 Volts 10% AC at 1.5 Amps and 1 Volt pk-pk composite video input.
Supplied with circuit diagram £33.50

KEYBOARD CASES

405 × 210mm. Panel size 330 × 188 mm £10.14
510 × 340mm. Panel size 430 × 115mm £26.22

EUROCARD 19" CARD FRAME

Kit of 2 end plates + angles. 2 front and 2 rear tie bars. 4 guide location strips	£28.84
Accessories	
Card guides (pack of 10)	£1.53
Connector mounting strips (pair)	£3.27
Case conversion kit	£19.80
(or fit into separate 3U 19" D-type case)	£32.58
DIN 41612 Eurocard Connectors	
64 way Plug rows a+c (64/96)	£2.22
64 way Socket rows a+c (64/96)	£3.39
64 way Plug rows a+b (64/64)	£2.71
64 way Socket rows a+b (64/64)	£4.24

These cut prices for Amateur Users and Export.
Note: industrial users quantity prices available.
Mostly Motorola, RCA

CMOS

4000	14p	4042	60p	4093	43p	4409	£7.90	4531	£1.30
4001	14p	4043	70p	4094	£1.68	4410	£7.20	4532	£1.10
4002	14p	4044	65p	4095	90p	4411	£6.95	4534	£5.00
4006	66p	4045	£1.70	4096	90p	4412VP	£8.00	4536	£2.95
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4008	62p	4047	75p	4098	88p	4422	£5.66	4538	£1.15
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4011	15p	4050	30p	40101	£1.30	4450	£3.50	4543	£1.35
4012	18p	4051	78p	40102	£1.80	4461	£3.93	4549	£3.95
4013	34p	4052	78p	40103	£1.75	4462	£4.41	4552	£14.85
4014	75p	4053	78p	40104	95p	4490PP	£3.50	4553	£2.99
4015	66p	4054	£1.25	40105	£1.15	4490VP	£3.14	4554	£1.38
4016	32p	4055	£1.25	40106	75p	4501	29p	4555	50p
4017	48p	4056	£1.20	40107	60p	4502	£1.20	4556	55p
4018	68p	4059	£4.80	40108	£4.50	4503	70p	4557	£3.20
4019	42p	4060	90p	40109	£1.00	4505	£5.71	4558	£1.20
4020	61p	4062T	£9.95	40110	£3.00	4506	50p	4559	£3.95
4021	70p	4063	99p	40114	£1.77	4507	40p	4560	£1.80
4022	66p	4066	36p	40160	£1.54	4508	£2.65	4561	81p
4023	20p	4067	£3.99	40161	£1.54	4510	68p	4562	£4.95
4024	45p	4068	22p	40162	£1.54	4511	68p	4566	£1.59
4025	19p	4069	20p	40163	£1.54	4512	75p	4568	£2.38
4026	£1.30	4070	26p	40174	£1.54	4513	£1.99	4569	£1.75
4027	38p	4071	20p	40181	£5.03	4514	£1.95	4572	36p
4028	58p	4072	20p	40182	£1.90	4515	£1.98	4580	£4.60
4029	77p	4073	20p	40192	£2.41	4516	75p	4581	£2.50
4030	50p	4075	20p	40193	£2.41	4517	£4.15	4582	99p
4031	£1.70	4076	60p	40194	£1.05	4518	42p	4583	90p
4032	£1.25	4077	26p	40208	£7.54	4519	29p	4584	48p
4033	£1.65	4078	26p	40257	£2.31	4529	78p	4597	£2.44
4034	£1.95	4081	26p	4160	95p	4521	£2.00	4598	£2.90
4035	95p	4082	26p	4161	99p	4522	£1.11	4599	£5.95
4037	£1.15	4085	65p	4162	99p	4526	95p	4700	£1.75
4038	£1.10	4086	65p	4163	99p	4527	£1.15	ICM7038A	£4.25
4039	£2.79	4086	70p	4174	99p	4528	80p		
4040	59p	4089	£1.40	4175	£1.05	4529	£1.30		
4041	78p			4194	£1.05	4530	70p		

74C

74C00	28p	74C76	57p	74C163	£1.15	74C904	57p	74C926	£5.99
74C02	28p	74C83	£1.34	74C164	£1.60	74C905	£7'53	74C927	£5.99
74C04	28p	74C85	£1.34	74C165	£1.08	74C905	57p	74C928	£5.99
74C08	28p	74C88	67p	74C173	93p	74C907	57p	74C929	£17.90
74C10	28p	74C89	£4.62	74C174	93p	74C908	£1.00	74C930	£17.90
74C14	30p	74C90	89p	74C175	93p	74C909	£1.69		
74C20	28p	74C93	90p	74C192	£1.15	74C909	£1.69	80C95	85p
74C30	28p	74C99	£1.06	74C193	£1.15	74C910	£7.45	80C96	92p
74C32	28p	74C107	£1.27	74C195	£1.00	74C911	£7.39	80C97	85p
74C42	95p	74C150	£3.81	74C200	£7.45	74C912	£7.39	80C98	92p
74C48	£1.43	74C151	£2.55	74C221	£1.41	74C914	£1.45	82C19	£6.20
74C73	57p	74C154	£3.81	74C373	£1.79	74C915	£1.15	88C29	£2.90
74C74	50p	74C157	£2.29	74C374	£1.79	74C918	£1.10	88C30	£2.90
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74LS00	12p	74LS55	30p	74LS151	39p	74LS243	85p	74LS367	37p
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74LS04	15p	74LS75	28p	74LS156	39p	74LS248	65p	74LS375	48p
74LS05	15p	75LS76	20p	74LS157	35p	74LS249	68p	74LS377	90p
74LS08	15p	74LS78	24p	74LS158	36p	74LS251	40p	74LS378	69p
74LS09	15p	74LS83	50p	74LS160	41p	74LS153	40p	74L379	65p
74LS10	15p	74LS85	70p	74LS161	41p	74LS257	48p	74LS384	86p
74LS11	15p	74LS86	38p	74LS162	41p	74LS258	40p	74LS386	86p
74LS12	15p	74LS90	35p	74LS163	41p	74LS259	85p	74LS390	62p
74LS13	30p	74LS91	80p	74LS164	48p	74LS260	21p	74LS393	60p
74LS14	48p	74LS92	36p	74LS165	75p	74LS261	£1.95	74LS395	£1.99
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74LS20	15p	74LS95	45p	74LS170	£1.70	74LS273	90p	74LS398	£2.75
74LS21	15p	74LS96	£1.16	74LS170	72p	74LS275	£2.50	74LS399	£2.20
74LS26	18p	74LS107	43p	74LS174	72p	74LS279	88p	74LS445	£1.40
74LS27	15p	74LS109	30p	74LS175	58p	74LS283	45p	74LS447	£1.44
74LS28	20p	74LS112	30p	74LS181	£1.30	74LS290	57p	74LS490	£1.80
74LS30	18p	74LS113	40p	74LS183	£2.75	74LS293	46p	74LS668	£1.75
74LS32	15p	74LS114	35p	74LS190	58p	74LS295	£2.15	74LS669	£1.50
74LS33	16p	74LS122	44p	74LS191	58p	74LS298	£1.30	74LS670	£1.75
74LS37	16p	74LS123	55p	74LS192	58p	74LS324	£2.00		
74LS38	16p	74LS124	£1.05	74LS193	65p	74LS325	£2.90		
74LS40	16p	74LS125	30p	74LS194	40p	74LS326	£2.90		
74LS42	35p	74LS126	30p	74LS194	40p	74LS326	£2.94		
74LS47	40p	74LS132	45p	74LS195	40p	74LS327	£2.86		
74LS48	80p	74LS136	28p	74LS196	58p	74LS347	£1.48		
74LS49	60p	74LS138	35p	74LS197	85p	74LS348	£1.86		
74LS51	15p	74LS139	38p	74LS221	60p	74LS352	£1.85		
74LS54	15p	74LS145	75p	74LS240	96p	74LS353	£1.85		
		74LS147	£1.70	74LS241	96p	74LS365	37p		
		74LS148	99p	74LS242	85p	74LS366	37p		

74S

74S04	73p

QUARTZ

32.768KHz (watch	£2.50
60 KHz	£9.95
100.0 KHz	£2.90
200.0 KHz	£3.70
204.8 KHz	£3.92
262.144 KHz	£3.92
307.2 KHz	£3.92
312.5 KHz	£3.92
455.0 KHz	£3.83
1.000 MHz	£2.95
1.008 MHz	£3.50
1.280 MHz	£3.92
1.6 MHz	£3.23
1.8 MHz	£3.23
1.8432 MHz	£2.99
2.000 MHz	£2.80
2.097152 MHz	£3.23
2.4576 MHz	£2.99
2.500 MHz	£3.92
2.56250 MHz	£3.62
3.000 MHz	£3.62
3.2768 MHz	£2.70
3.579545 MHz	£1.75
3.93216 MHz	£3.92
4.000 MHz	£1.99
4.032 MHz	£1.99
4.096 MHz	£1.99
4.194304 MHz	£1.99
4.433619 MHz	£1.25
4.608 MHz	£3.23
4.800 MHz	£1.99
4.9152 MHz	£3.23
5.000 MHz	£1.99
5.0688 MHz	£2.70
5.120 MHz	£3.23
5.185 MHz	£3.23
5.24288 MHz	£4.25
6.000 MHz	£2.70
6.144 MHz	£2.70
6.400 MHz	£3.23
6.55360 MHz	£1.99
7.000 MHz	£1.99
7.168 MHz	£2.50
7.680 MHz	£1.99
7.86432 MHz	£3.23
8.000 MHz	£1.99
8.08333 MHz	£3.62
8.388608 MHz	£3.23
8.867237 MHz	£2.99
9.375 MHz	£3.23
10.000 MHz	£1.99
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.50
14.0 MHz	£3.92
14.31818 MHz	£3.62
16.000 MHz	£2.90
18.000 MHz	£2.50
18.432 MHz	£2.90
19.968 MHz	£3.00
20.000 MHz	£2.80
20.1134 MHz	£3.23
24.0 MHz	£3.92
26.690 MHz	£2.90
27.0 MHz	£3.92
27.145 MHz	£3.00
27.648 MHz	£3.23
38.6666 MHz	£3.50
48.000 MHz	£2.70
100.000 MHz	£2.90
116.000 MHz	£3.00

VEROBOARD
0.1" Pitch with copper strips

2½"×1" (pack of 5)	£1.01
2½"×3¾"	73p
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3¾"×3¾"	83p
3¾"×5"	95p
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0.1" Plainboard (no strips)	
3¾"×2½"	52p
3¾"×5"	79p
3¾"×17.0"	£2.11
Terminal pins	£1.50/500
V-Q DIP board	£1.58
DIP breadboard	£3.59
Spot face cutter	£1.18
Pin insertion tool	£1.62

SOLDERCON PINS
100 70p
500 £3.25 1000 £6.00

DIL SOCKETS
8/14/16 pin 8p/10p/10p
18/20/22 pin 16p/22p/25p
24/28/40 pin 25p/28p/30p
24pin Textool lever type zero insertion force £6.00

EDGE CONNECTORS
43 way. 0.1" pitch. wire wrap. polarizing slot pin 37
Single sided (1×42) £3.11
Double sided (2×42) £4.10

TIMER ICs
555/556 16p/49p

OP-AMPS
(All Mini dips)

CA 3130E	90p
CA 3140E	48p
741	14p

LED DISPLAYS

DL-704E	99p
DL-727E/728E	£2.00
DL-747E/750E	£1.80
FND 500/560	£1.20

LIQUID CRYSTAL DISPLAY
4×0.5" Digits 40 pin DIL £9.75

CLOCK CHIPS

AY-5-1224A	£2.60
MK 50253	£5.50
MK 50366	£6.50

SIX DECADE COUNTERS

MK 50395/6/7	£9.90
50399	£7.50

TRANSISTORS

BC 107/8/9	10p
BC 177	20p
BC 213L	10p
BC 461	34p
BC 548	14p
2N 3703/4/5/6	10p
2N 3820	45p
TIP 2955	60p
TIP 3055	60p

DIODES

IN 4148	4p
IN 4001/2	5p
IN 4003/4/5	6p
IN 5401	15p
IA BRIDGE 150V	22p

SIL RESISTORS

7 × 10K (8 pin)	42p
8 × 10K (9 pin)	46p
8 × 4K7 (9 pin)	46p
8 × 1K (9 pin)	46p

DIL RESISTORS
8 × 33R (16 pin) 62p

RESISTORS
Carbon film, high stability ¼W E12 range 2p each
100 of one value £1.00

CERAMIC CAPACITATORS
10pF, 15pF, 22pF, 33pF, 47pF, 68pF, 100pF, 150pF, 220pF, 470pF, 1n5F, 2n2F, 3n3F, 4n7F, 6n8F, 10nF all at 4p each
15nF, 22nF, 47nF at 5p each
100nF at 7p

MICROPROCESSORS

6502	
6502	£4.50
6520/21	£3.10
6522	£4.85
6532	£7.75
Z80	
Z80A CPU	£4.50
Z80A P10	£3.78
Z80A CTC	£4.00
Z80A-S10/10	£13.95
6800	
6800 MPU	£3.25
6802 MPU	£4.25
6809	£8.75
6810 (128 × 8 RAM)	£1.30
68A10 (128 × 8 RAM)	£1.30
6820, 6821 P1A	£1.60
6845	£9.50
6850 ACIA	£1.60
MC6880	£1.20
SC/MP II RAM I/O	
SC/MP II (4MHz)	£10.47
INS 8154 RAM I/O	£9.52
INS 8255 I/O	£3.60
CMOS	
COSMAC CDP 1802CE	£6.50
COSMAC CDP 1802E	£10.85
CDP 1864	£6.45
STATICS (Mostly 450nS)	
2114L 200nS	95p
2114L 300nS	90p
6116 CMOS 2K RAM 200nS	£5.90
6116 8 off	
4118 – 1K×8	£3.70

DYNAMICS	
4116 16K 200nS	75p
8×4116	£6.00
4164	£7.98
UV ERASABLES	
5204 (512×8)	£7.95
2708 1K×8	£1.75
2716/2516 2K×8 single 5v	£1.95
2532 4K×8 (5v)	£4.05
2732 4K×8 5v	£4.05

PROM WASHING SERVICE
50p each prom

SPARE ERASER TUBE	
U-V tube ("12")	£10.00
UV PROM ERASER	
UV140	£61.20
UV141	£77.70
EPROMPT	£33.00
INTERFACE	
81LS 95	90p
81LS 96/97	90£
81LS 98	90p
1488	62p
1489	62p
75491	50p
75492	92p
8T26/28	£1.50
1L74	48p
AY-3-8910	£5.95
FD 1771	£18.00
8131	£2.50
8136	£2.50
ICM 7209 IPA	£2.69

SAA5050	£8.51
SAA5020	£5.33
CRT CONTROLLER: Uarts	
AY-5-1013	£3.45
AY-3-1014A	£5.50
AY-3-1015	£3.00
6402	£3.92
1402	£4.50
CHAB. GEN. KEYBOARD ENCODER	
MK 2302	£15.29
RO-3-2513 (5v. Uppercase)	£5.75
AY-5-2376	£5.99
FIRMWARE	
2K ZYMON for Z80 (1 × 2516) includes commented listing	£14.95
1K ZMON Z80 (1 × 2516 or 1 × 2708)	£14.95
2K Tiny Basic for Z80 (1 × 2516)	£14.95
4K NIBL for SC/MP (4 × 2708)	£49.95
4K NIBL-MM for SC/MP (4 × 2708)	£49.95
(Description leaflet available)	
1K Elektor Junior (1 × 2708)	£19.85
1½K ELBUG (3 × 5204)	£35.00
ETIBUG (1 × 5204)	£35.00
ETIBUG (1 × 5204)	£14.95
ETIBUG 2 (1 × 5204)	£14.95
SCMP/KB (1 × 5204)	£14.95

UHF MODULATORS

UM1111 E36 Vision modulator, TV game or cheap computer type £2.80

UM1233 E36 Wide bandwidth, computer VDU type £4.50

UM1286 E36 Combined wide bandwidth vision modulator with intercarrier sound, high performance £8.25

VOLTAGE REGULATORS

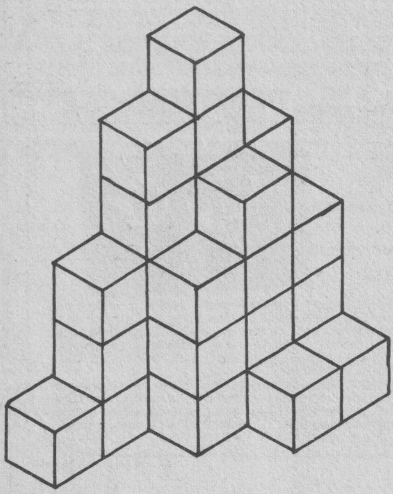
7805	45p
7905	55p
7812	48p
7912	55p

VOLTAGE CONVERTER MODULES

Ideal for use in otherwise 5V only systems, to obtain +12V. −12V. or dual 12V power for ASCII keyboards, RS 232 Interfaces, dynamic RAMs, etc. All types need +5V input. Size of each module (excluding pins) 34 × 26 × 10mm.

Type ADIP-12A10
+12V. output (25-84mA) .. £4.95
Type ADIN-12A10
−12V. output (25-84mA) .. £4.95
Type ADID-12A10
± 12V. dual output, 2 × (12-42mA) £5.25

WIN £50's WORTH OF VEROBOXES!



There's no doubt that no matter how clever the project you've built is, your friends and family are not going to be impressed with it if you display it in a card-board box or the proverbial tobacco tins. What's more, the feeling of satisfaction you get from project-building can be that much greater if you end up with something that looks as good as commercial equipment.

One of the companies with the largest range of cases is Vero Industries. They've given us a collection of their cases worth £50, and we're going to give them to one of you — but the lucky recipient has to have answered these three questions correctly.

(1) How many boxes in the pile on the left? (There are no concealed box tops).

(2) How many of this month's projects are housed in Veroboxes?

(3) Is the Vero 'G' range of cases made from plastic or metal?

Answers on the form on page 133 please, together with your name and address, to reach us before April 30th, 1982.

RULES

1. Closing date is April 30th 1982, and all entries post-marked later than this date will be discounted.
2. The coupon provided in the magazine must be used. Photocopies are NOT acceptable.
3. Employees of ASP and their relatives are not eligible for entry.
4. The judges' decision is to be considered final and no correspondence will be entered into concerning the competition.

TTL CMOS 74LS LEDS **LB ELECTRONICS** LINEAR RAMS EPROMS SURPLUS TELEPHONE: UXBRIDGE 55399

D TYPE CONNECTORS

9 way r/angle skt	£1.25
9 way (solder) skt	£0.75
9 way (crimp) plg	£0.75
15 way (w/wrap) plg	£1.00
15 way (solder) plg	£0.95
15 way (solder) skt	£0.95
25 way (solder) plg	£1.85
25 way (solder) skt	£1.85
25 way (ins/peirce) plg	£2.65
25 way (ins/peirce) skt	£2.65
25 way (w/wrap) skt	£2.00
37 way (solder/tail) plg	£1.80
37 way (solder/tail)	£1.80
50 way (solder/tail) plg	£2.00
50 way (solder/tail) skt	£2.00

'D' TYPE COVERS

Plastic 9 way	£0.60
Plastic 15 way	£0.50
Plastic 25 way	£0.95
Plastic 37 way	£1.00
Plastic 50 way	£1.20
Metal 15 way	£0.95
Metal (ITT) 25 way	£1.00
Metal 25 way	£1.25
Metal (ITT) 50 way	£1.25
Metal 50 way	£1.85

P/P on all above items **45p**

SUPERSAVER 30
PAPST Minifan 3¼" sq. 1½" deep 220V. 50 HZ. Brand new and boxed **£9.50 P/P 50p**

SUPERSAVER 31
UECL Gold plated Edge connector .1" 75 way **£1.65 PP 45p** (wire wrap)

SUPERSAVER 32
12 Volt Relay. P.C.B. Mntg S/pole d/CHANGE over **£0.65 P/P 25p**

SUPERSAVER 33
JECKSON NICAD **£8.75**
Batt charger for 4 × AA, D, D. Same as above plus P.P.3. **£10.00 P/P £1.00 each**

SUPERSAVER 34
ANTEX 15 watt solder iron **£4.95 P/P 75p**

SUPERSAVER 35
A Treat '82. 16 meters of 16 core cable with non-standard 'D' type plg/skt **£1.50 P/P £1.00**

SUPERSAVER 36
Mains lead 2 meters + with moulded I.E.C. mains plug 6A 250V **£1.00 each P/P 50p**

SUPERSAVER 37
MEKTRON M-823793 16 way buss rail. 4 for **£1.00 P/P 35p**

SUPERSAVER 38
T&B Ansley I.D.C. Connectors

26 way straight plug	65p
40 way straight plug	90p
40 way R/A plug	£1.00
16 way skt	55p P/P 25 each

SUPERSAVER 39
MOLEX 6W skt. .1" will butt end to end still giving .1" PCB mounting. 4 for **12p**; 12W plg **12p** each.
16W plg & skt **45p for pair.**
2W plg & skt **25p for pair.**
3V plg & skt (mains) **45p for pair**
P/P 25p.

SUPERSAVER 40
.1" 30 × 30 Gold plated P.C.B. plug. **£1.00 each.**
.1" 20 way PCB skt **20p each.**
36W plg .1" R/A **50p each.**
P/P **25p each.**

SUPERSAVER 41
AUGAT IC skts (The best available) round turned pins. The I.C. pin cuts a groove in the skt for 100% connection reliability. 16 way **20p**; 18 way **25p**; 24 way **50p** each. P/P **25p.**

SUPERSAVER 42
Header plgs (gold plated)

14 way (no CVR)	18p each
16 way (no CVR)	25p each
24 way (no CVR)	95p each
14 way HDR plgs with CVR	45p each
16 way HDR plgs with CVR	60p each
Ansley 14 way HDR plgs RBN I/P	75p
Ansley 16 way HDR plgs RBN I/P	95p
Ansley 24 way HDR plgs RBN I/P	£1.50 P/P 15p each

SUPERSAVER 43
2516 used fully erazed guaranteed replacement single rail EPROM 350ns **£1.95** each; Ten for **£17.00 P/P FREE**

SUPERSAVER 44
Tangerine Microtan 65 blank P.C.B. Brand new + circ. diagram **£4.50** (6502 based, IK on board) P/P **50p each.**

MICRO REVOLUTION
The new Z8 Processor complete P.C.B. and parts to produce this new R.S. 232 CPU. Built in tiny BASIC and 4K RAM only 4.5" by 4.5". Price on application. Further details to follow.

SUPERSAVER 45
M.C. 1489 RS 232 Receiver I.C. **46p each P/P 20p**

SUPERSAVER 46

2708	£1.85 ea.
1702	£5.00 ea.
2732	£5.50 ea.
2532	£6.50 ea.
2114 (450ns)	£1.00 ea.
2114L (450ns)	£1.35 ea.
2114 (200ns)	£1.45 ea.
4116 (200ns)	£1.00 ea.

Quantity on above P.O.A.
P/P FREE

SUPERSAVER 47
Approx. 2 meters + coax lead with plgs either end **£1.00 each** P/P **35p**

SUPERSAVER 48
FND 500 .5" LED displays. 7 seg. Red. **65p each.** Large quantity P.O.A. P/P **35p**

SUPERSAVER 49
64 way DIN41612 edge connectors to fit Microtan etc. plg or skt **£3.45 each P/P 35p each**
Amphenol 36 way plg & skt (used) to fit all your printers **£2.75 per pair P/P 35p**

SUPERSAVER 50
2.5mm Power plg + 2 metres of cable to fit Acorn Atom ZX81 etc. etc. Only **£1.00** for 10. P/P **25p.**
TRADE ENQUIRIES WELCOME

POSTAGE STATED IS FOR ONE ITEM. IF YOU ORDER SEVERAL ITEMS, PLEASE USE YOUR OWN DISCRETION.

SUPPORT DEVICES

8251	£3.00 each
8253	£6.00 each
8224	£2.00 each

P/P **35p**

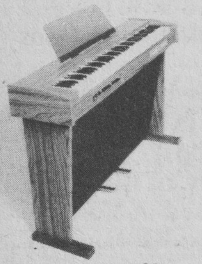
L.B. ELECTRONICS
11 HERCIES ROAD, HILLINGDON, MIDDLESEX UB10 9LS
TEL: UXBRIDGE 55399

CLEF ELECTRONIC MUSIC

ELECTRONIC PIANOS

SPECIALISTS SINCE 1972

Clef Pianos adopt the most advanced form of Touch Sensitive action which simulates piano Key inertia using a patented electronic technique.



7¼ OCTAVE DOMESTIC MODEL

COMPONENT KIT £244

COMPLETE KIT £395.70

MANUFACTURED £675

Two Domestic Models are available including the 88-note full-size version. Four intermixable Voice Controls may be used to obtain a wide variation of Piano tone, including Harpsichord. Both Soft and Sustain Pedals are incorporated in the Design and internal Effects are provided in the form of Tremolo, Honky-Chorus, and Phase/Flanger.
A power amplifier integrates into the Piano top which may be removed from the Base for easy transportation.

COMPLETE KIT £358.70

SIX OCTAVE DOMESTIC MODEL

COMPONENT KIT £217

MANUFACTURED £595

Component Kits include Keyboard, Key-switch hardware, and all electronic components and may be purchased in four stages at no extra cost.
Complete Kits further contain Cabinets, wiring harness, Pedals and in the case of Domestic Models both Power Amplifier and Speaker.
The Six Octave Stage Piano has the same range of Voices and Effects and is designed for use with an External Amplifier and Speaker.

COMPLETE KIT £345

SIX OCTAVE STAGE MODEL

COMPONENT KIT £217

MANUFACTURED £530

Since 1972 Clef Products have consistently produced leading designs in the field of Electronic Musical Instruments, many of which have been published in technical magazines. With musical quality of paramount importance, new techniques have been evolved and the latest musically valid technology has been incorporated into projects which have been successfully completed by constructors over a wide range of technical capability. Back-up TELEPHONE advice to our customers is available from the Designer of all Kits advertised.

STRING ENSEMBLE

(As Published in conjunction with 'Practical Electronics')

A very popular Keyboard Synthesizer Kit, for Group or Home use, with a four octave compass and split Keyboard facility.
The instrument is fully polyphonic and has two rich Multi-String Voices plus Woodwind and Brass Effects for individual or Mixed use. Variable Attack and Sustain Controls give a good Orchestral Mix with the added concert hall reverberation effect produced by sustain coupled with phase modulation in the Chorus Unit. The Component Kit includes Keyboard, Key-switch hardware, and all electronic components plus tone generator linking wire and Volume Pedal. A copy of the P.E. project series can be supplied for £3.00 inc. post.

COMPONENT KIT £179.00

ROTOR-CHORUS

Comprehensive two speed organ rotor simulator plus a three phase chorus generator on a single 8″ × 5″ pcb. The kit includes all components for mains operation and a stereo headphone driver pcb. Easily integrated with existing organ/amplifier system.

COMPONENT KIT £89.00

KEYBOARDS

Our Square Front Keyboards are chosen for their superior feel to the discerning musician whilst giving adequate physical strength for the high impact playing present in the Piano application.

88 NOTE (A-C) £57.00
73 NOTE (F-F) £47.00
FIVE OCTAVE £38.00
FOUR OCTAVE £28.75

EXPERIMENTERS

A number of our Sub-Kits are of interest to Electronic Music and COMPUTER Experimenters. These include the 6502 based MICRO-CONTROLLER and Music system kit used in the BAND-BOX, plus a 49 note four pitch diode Keyswitch system. See our lists for Sub-Kit prices.

PRICES INCLUDE VAT, UK CARRIAGE & INSURANCE (CARRIAGE EXTRA ON MFD PIANOS). Please send S.A.E. for our complete lists, or use our telephone VSA/ACCESS Service. Competitive quotations can be given for EXPORT orders – in Australia please contact JAYCAR in Sydney.

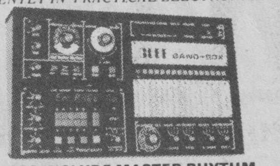
CLEF PRODUCTS (ELECTRONICS) LIMITED
(Dept. ETI) 44A Bramhall Lane South, Bramhall, Stockport, Cheshire SK7 1AH 061-439 3297

"THE COMPUTER BAND-BOX"

CURRENTLY IN 'PRACTICAL ELECTRONICS'

COMPLETE KIT £289

£399 MANFD.



PRICES INCLUDE MASTER RHYTHM

A revolution in the field of Computer Music Generation!

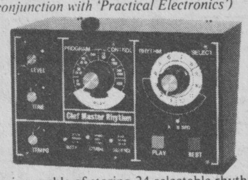
A MUSICIANS INSTRUMENT FOR:
SOLOISTS – SINGERS – RECORDING – PRACTICE
LIVE PERFORMANCE –COMPOSITION

The BAND-BOX provides an Electronic Backing Trio consisting of Drums, Bass, and a Chord Instrument (one of 16 Waveform/Enevelope combinations), with the capicity to store over 3,000 User Programmable Chord Changes on more than 120 different Chords. Using advanced Microprocessor technology, Playback of 50-100 Scores can be executed in any Key and at chosen Tempo. Complete Music Pad is electronically Indexed and stored on secondary battery back-up. Facility exists for composition of Intro, Repeat Chorus, and Coda sections including Multiple Score Sequences. Sockets are provided for Volume Pedal and Footswitch plus separate and mixed instrument Outputs. Total size 19″ × 11″ × 4½″ incorporating Master Rhythm.

THE Programmable DRUM MACHINE

(As Published in conjunction with 'Practical Electronics')

EIGHT TRACK PROGRAMMING /TWENTY-FOUR PATTERNS/ TWELVE INSTRUMENTS SEQUENCE OPERATION.
COMPLETE KIT £79.00
MANFD. £119.00



The Clef Master Rhythm is capable of storing 24 selectable rhythmic drum patterns, invented, modified, and entered by the Operator on to Eight Instrumentation tracks. A three position Instrumentation control expands the number of instruments available to twelve, grouped into sounds typical of playing with Drumsticks, Brushes, or Latin American Bongos and Claves.
Sequence operation allows two rhythm sections to be coupled with the second (B) section appearing at four, eight or sixteen Bar repetition. All drums can be adjusted for level and resonance on internal controls to suit individual taste, thus producing good musical sounds in a battery driven unit 8½″ × 5″ × 2½″.

POWER DIMMING MODULES

★ Fully isolated
★ Multi channel common wiring lines
★ Master dimming over banks
★ Remote override
★ Dead "kill" and "all on"
★ Low voltage feed lines
★ Common neutral or live outputs

Power Dimming Modules

A range of isolated digitally controlled dimming modules, complete with panels. Each type requires connection to the supply/reference board.

Slave power controllers (SPC)
Controls up to 1000W via the slider. RFI suppressed/fused.
Slave power unit (SPU)
Controls up to 1000W via a logic signal from a remote slave.
Master controllers (MC)
Will master dim from 1 to a bank of 20 SPC units.
Remote slaves (RS) — (Preset)
Will override an SPC at a remote location to the main system or control an SPU.
Supply/reference board
Provides the necessary supply voltages and signals to all units. Facilities for "Kill" and "all on." Supplies up to any combination of 50 modules.

PRICES (1 of)
SPC £13.90
SPU £9.90
MC.................. £7.20
RS.................. £8.50
Supply........... £18.20

SPECIAL DISCOUNTS
Are available on power dimmers.
Total your order up and deduct:
£100 to £199.... 20%
£200 to £299.... 25%
£300 to £399.... 30%
£400 + ... 40%

PROGRAMMABLE — 8

£114.90

P/P INS
£1.50

Complete with blue panel/white letters

★ 8 channel 400W each
★ 16, 32, 64, 128 patterns
★ Automatic program recycle
★ Adjustable cucle on/off speed
★ Optically isolated, suppressed
★ Either common Neutral or live lamps

An advanced lighting module allowing any chase or sequence effects to be programmed, stored and recalled. Up to 128 patterns can then be replayed in the stored order, with control over the cycle on and off time. At the end of the program the system re-cycles to the start to maintain a continuous display. Full monitoring on the control panel over the outputs and control status is provided, and the program may be halted at any time. Although removing the mains supply to the module will delete the stored patterns the use of calculator type push buttons allows speedy programming ready for the following night's performance. The module obviously provides unlimited effects and is a must for all serious lighting shows.

3 CHANNEL SOUND/LIGHT CHASER

LB31000SLC **£35.70**

A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti-interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel, 5HZ to 70K. Controls: bass/mid/treble/master sensitivity/chase speed.

STEREO DISCO MIXER/PREAMP

LBPA3
M – Magnetic
C – Ceramic

£33.70

Magnetic or ceramic deck versions – please state

All the requirements of a stereo disco preamp on one board, left and right deck mixers/tone controls/misc. mixer/tones/mic. auto fade over decks/and P.F.L. The unit can be used with either LB 100/150/250.

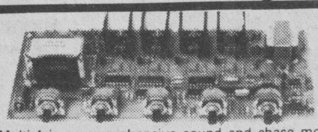
NEW NEW NEW

4 CHANNEL SOUND LIGHT AUTO-CHASER

* Bass/mid/presence/treb
* Automatic level filter control
* Automatic input gain control
* L.E.D. monitor drivers
* 10Hz to 30KHz response
* Super sensitive
* Zero reference triggering
* Fascia/LED, etc. available
* **£49.90** (panels, etc. £9.20)

Phone or write for immediate details of the LB41000SLC

NEW NEW NEW



MULTI - 4

£48.90

The Multi-4 is a comprehensive sound and chase module, offering a wide range of forward, reverse or random effects, with additional sound modulation facilities. Modes of operation are set on control pots which act as electronic switches. The unit has a wide speed range and will accept virtually any sound level input. The Multi-4 also provides monitor circuits for LED driving. The triac outputs may be used to drive up to 4000W of lighting or up to ˙0 metres of rope lights.

Attractive blue panels with white letters, complete with LED monitors, knobs and mains illuminated switch.

extra £9.70

2/4/8 CHANNEL CHASER

LB81000LC

£28.00

An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswich trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

3 CHANNEL SOUND/LIGHT

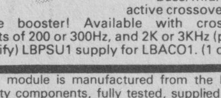
LB31000SL

£22.70

All the advantages of the SLC without chase.
Controls: bass/mid/treble/master sensitivity.

3-WAY ACTIVE CROSSOVER

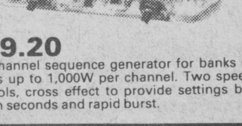
LBACO1
£17.90



Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBACO1. (1 or 2).

4 CHANNEL SEQUENCER

LB41000LS



£19.20

A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

L & B ELECTRONIC MODULES

PROFESSIONAL ENGINEERING BY PROFESSIONALS

45 Wortley Road, West Croydon Surrey CR0 3EB. Tel. 01-689 4138

Each module is manufactured from the highest quality components, fully tested, supplied with a connection and circuit diagram and guaranteed for twelve months.
All prices shown are VAT inclusive. Please include 75p post/packing except where individually stated. To mail order send cheque/P.O./Registered cash/Access number. C.O.D. service £1 extra. For further information send a s.a.e. stating which model.
PLEASE NOTE THIS COMPANY HAS NO CONNECTION WITH LB ELECTRONICS OF HILLINGDON

TECH TIPS

Frequency-To-Phase Controlled Power Supply

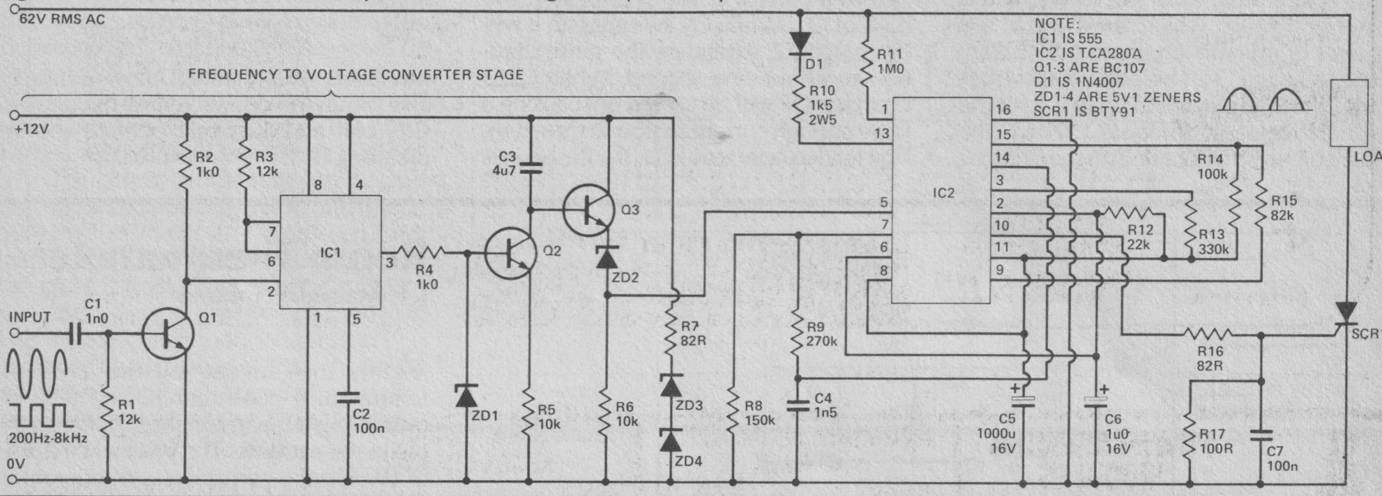
Dilbay Singh (B.Tech), Crawley

The circuit shown in the diagram was initially designed to obtain a phase-controlled power supply to use with a ¼ horsepower stepping motor. The phase angle can be varied over the complete cycle period and is dependent on the *frequency* of the input. Clearly the circuit can be used to control resistive loads such as lamps or motors.

The first stage of the circuit consists of a frequency-to-voltage converter. C1, R1, and Q1 effectively differentiate and amplify the input signal waveform to provide triggering pulses for the 555 timer, which is used in the monostable mode. The output of the monostable is used to charge C3 by a constant amount of charge every time a pulse is received at the base of Q2. The voltage across C3 acts as an input to the common collector stage formed by Q3. The voltage across C3 is DC-shifted by means of the zener diode ZD2 to a suitable value, providing the input to the trigger IC (the Mullard TCA280A). The TCA280A provides the phase control signal for the gate of the thyristor.

A triac may be used in place of the thyristor, if phase-controlled AC is required.

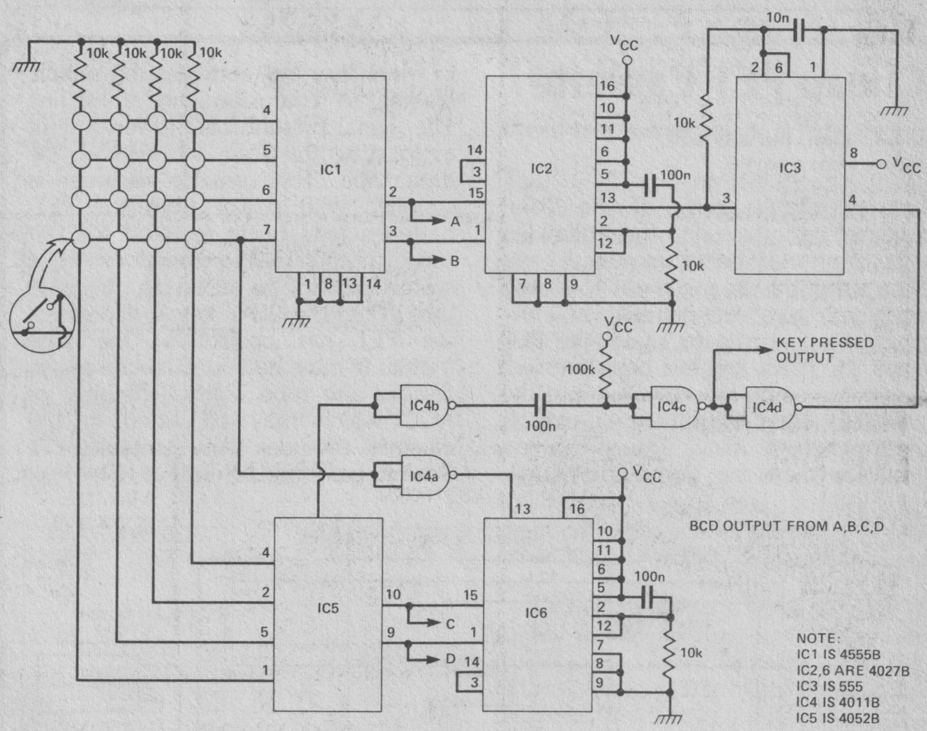
The component values shown are suitable for providing phase control using frequencies in the range 200 Hz-8 kHz on the control input. The firing angle can be varied from 0° at 8 kHz to 170° at 200 Hz.



Fully Debounced Keyboard

Graham Kyte, Bexleyheath

This circuit produces a debounced output whenever a key is pressed. Each matrix point is scanned in turn and the output of the 4052 data distributor goes high when a pressed key is detected. This stops the scanning oscillator (555) for about 10 mS and a 'key pressed' output is produced, thus enabling the BCD output to be stored in a latch or otherwise made use of. The use of CMOS ICs enables current consumption to be minimised, making the circuit suitable for operation in a car. The circuit is easily modified for a larger number of keys by using an eight-way data distributor (with relevent counter made from three J-K flip-flops rather than the two as used here).



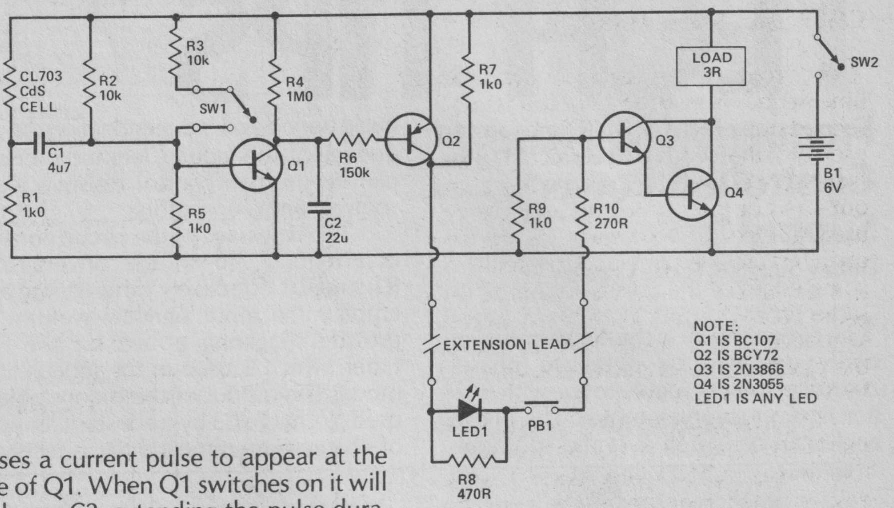
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for at a competitive rate. Drawings should be as clear as possible and the text should be typed. Text and drawings must be on separate sheets. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

Remote Camera Release

Geoffrey Ammon, Welling

When taking photographs from a distance, a pneumatic remote release is normally used. These will only work over a limited distance and it is not always possible to tell if the camera has operated. This simple circuit uses a low current trigger circuit to operate the camera and provides a visible indication that the camera or flashgun has worked correctly.

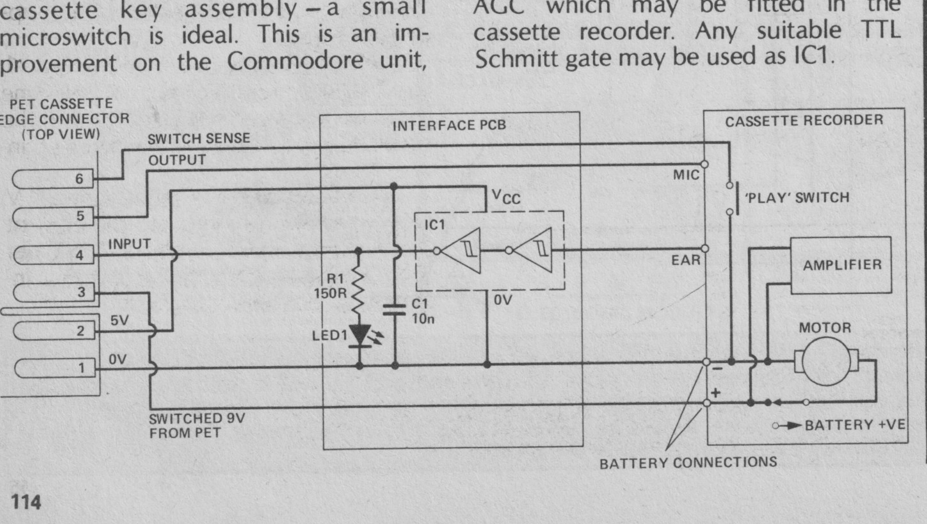
The circuit operation is as follows. When the remote release push-button PB1 is operated, a current flows via the extension lead, which may be a 100 metres or more in length, to switch transistors Q3 and Q4. This combination provides the load current of up to 2 A for the camera release solenoid. When the flashgun fires, light falling on the CdS cell causes a current pulse to appear at the base of Q1. When Q1 switches on it will discharge C2, extending the pulse duration to about one second. While C2 is charging Q2 will be turned on, causing a large enough current to flow in the extension lead to operate LED1. If a flashgun is not used, the camera flash contacts (SW1) may be connected to bypass the CdS cell and remotely operate the indicator LED1.



Cheap PET Cassette

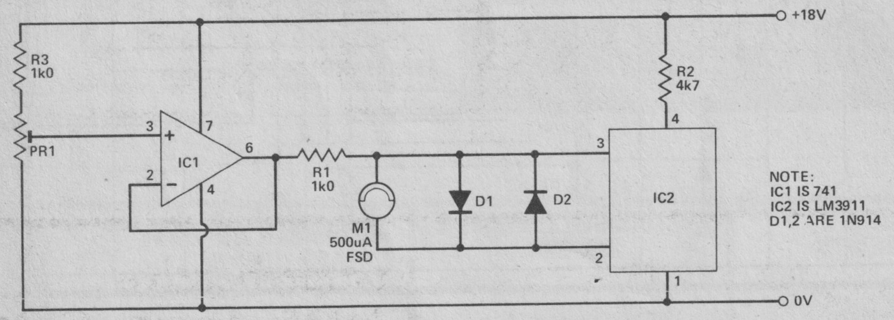
D.J. Cocker, Portsmouth

In view of the price of the Commodore cassette unit, the following adaptation may be of interest. I have been using this arrangement for some time and have experienced very few problems. In order to signal the PET when the PLAY key has been pressed, a switch mus be incorporated into the cassette key assembly – a small microswitch is ideal. This is an improvement on the Commodore unit, in which any key activates the switch, leading to confusion and ambiguity. The 'signal present' LED is very useful in locating the start and end of the data tape. The cassette recorder is supplied with power from the PET, batteries only being required for fast forward and rewind functions — a switch should be fitted to facilitate this. When the PLAY key is depressed, the PET has control of the tape motor. It may be found necessary to disable any tone control circuitry or AGC which may be fitted in the cassette recorder. Any suitable TTL Schmitt gate may be used as IC1.



Room Thermometer

J. P. Macaulay, Crawley



With the advent of the LM3911 temperature controller IC the task of measuring temperature has become simple in the extreme. The internal circuitry of this device comprises a temperature sensing element, an op-amp and a stable reference voltage. The device gives, in its simplest form, a stable 10 mV change in output for every 1° change in temperature over the range −25 to 85°C. For the application of room thermometer it is only necessary to utilise part of this range from, say, 0° −50°C. The circuit to be described measures this range.

The figure shows the complete circuit of the thermometer. The meter, a 500 uA FSD type, is connected between the output and inverting input of the internal op-amp. Resistor R1 connects the inverting input to the output of the 741 op-amp. This is used with 100% AC and DC feedback to form a unity gain voltage follower with a current output capacity of several milliamps. The input of the 741 is connected to the slider of PR1 which in turn is connected across the stable supply voltage produced by the IC. D1 and D2 protect the meter from overrange temperatures and thus protect its delicate movement from harm.

Once completed, a calibration can be made with a room thermometer of known accuracy. Simply leave the equipment in the room for 10 minutes or so for its own temperature to stabilise and then adjust PR1 until both thermometers read the same; the calibration is now complete.

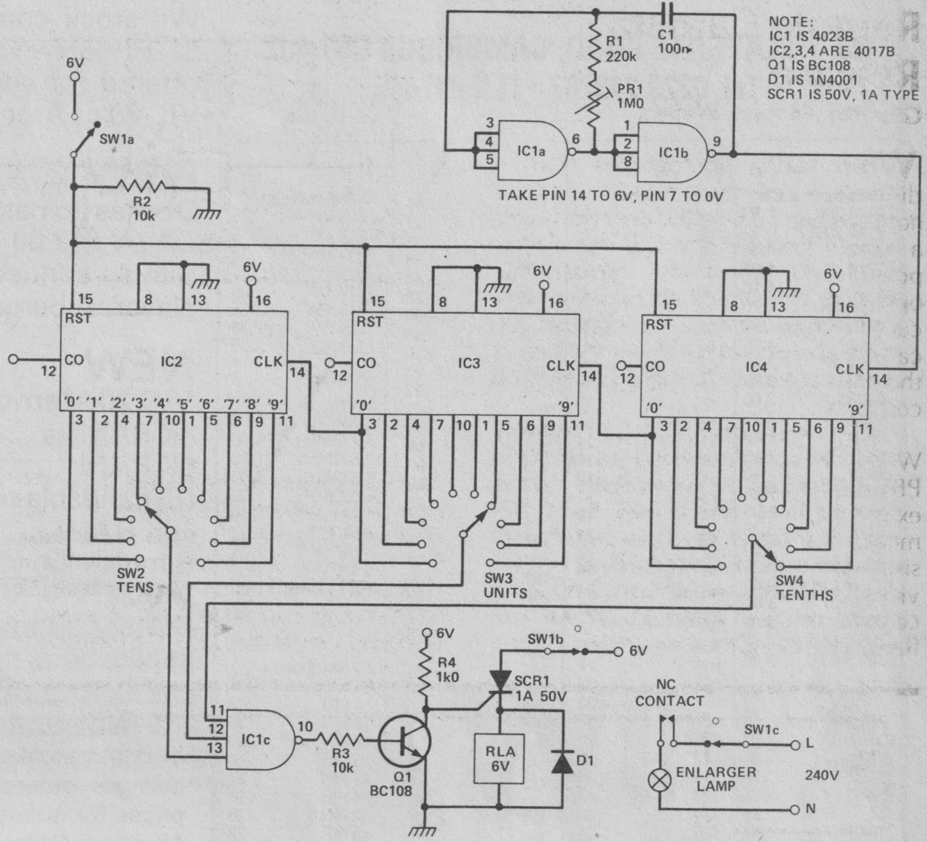
Enlarger Timer

C. E. Basson, South Africa

The circuit of the enlarger timer can time periods from 0 to 99.9 seconds in 0.1 second steps. PR1, C1, R1, IC1a,b form an oscillator that feeds a 10 Hz signal to the first 4017 counter stage. Either the 'carry out' or '0' outputs of IC2 and IC3 can be used to feed the next stage, as the frequencies are the same and the positive-going edges of the pulses appear at the same time. Outputs '0' to '9' go high in sequence as the pulses are received at the 'clock in'. The desired time is selected by SW2, SW3 and SW4.

Q1 is used as an inverter and with the NAND gate it performs the same function as an AND gate. As soon as the desired time is reached, all the inputs on the gate will be high and this will trigger SCR1. The relay will be turned on and switch off the enlarger lamp. The lamp will remain off until the circuit is reset.

The circuit can be resetted by closing SW1a and opening SW1b and SW1c. SW1a will reset the 4017s and keep them in the reset condition. SW1b will remove the current from SCR1 to reset it. SW1c prevents the light from going on when in the reset condition. When SW1 is switched back to normal, the light will go on and remain on for the desired time.



Comprehensive CMOS Logic Gate Test Rig

David Ian, Surrey

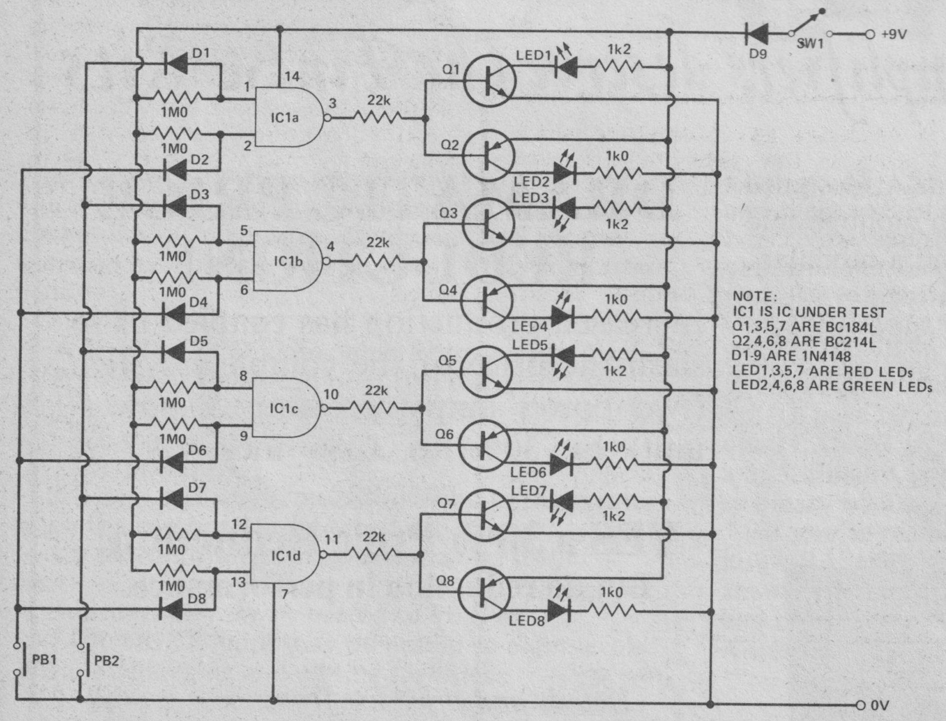
This simple test rig will check out all possible functions of any type of dual input CMOS logic gate allowing, for example, a faulty gate to be pinpointed so that the rest of the IC may still be used.

Each gate is provided with a green LED to indicate a high output and a red LED to show a low output.

Use a 14-pin holder for the IC and orientate the LEDs to relate to their appropriate gate.

SW1 connects power and a logic 1 to all inputs: press A to put a 0 onto one input of each gate; B puts 0 onto the other inputs; A and B togther force all inputs low.

A milliammeter in series with a 9 V supply should only indicate the current drawn by the LEDs, ie about 7 mA per LED. An appreciably higher reading indicates a completely faulty IC.



4011 (NAND)	GREEN	RED
SW1	ON	OFF
PB1	OFF	ON
PB2	OFF	ON
BOTH	OFF	ON

4001 (NOR)	GREEN	RED
SW1	ON	OFF
PB1	ON	OFF
PB2	ON	OFF
BOTH	OFF	ON

4081 (AND)	GREEN	RED
SW1	OFF	ON
PB1	ON	OFF
PB2	ON	OFF
BOTH	ON	OFF

4071 (OR)	GREEN	RED
SW1	OFF	ON
PB1	OFF	ON
PB2	OFF	ON
BOTH	ON	OFF

4070 (EXOR)	GREEN	RED
SW1	ON	OFF
PB1	OFF	ON
PB2	OFF	ON
BOTH	ON	OFF

4077 (EXNOR)	GREEN	RED
SW1	OFF	ON
PB1	ON	OFF
PB2	ON	OFF
BOTH	OFF	ON

SW1 ONLY – BOTH INPUTS HIGH
PB1 PRESSED – ONE INPUT LOW
PB2 PRESSED – OTHER INPUT LOW
BOTH PRESSED – BOTH INPUTS LOW

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74	.16
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85	.60
86	.15
90	.30
91	.74
92	.33
93	.33
95	.42
109	.21
112	.21
113	.21
123	.43
124	.90
125	.24
126	.25
132	.44
138	.33
145	.74
148	.95
151	.30
153	.28
154	.80
155	.38
156	.36
157	.30
161	.37
162	.40
163	.38
164	.46
165	.90
173	.69
174	.46
175	.46
193	.45
196	.57
197	.60
240	.87
241	.87
242	.78
244	.60
245	.88
247	.60
248	.60
257	.43
259	.78
266	.22
273	.70
290	.55
373	.70
374	.72
393	.60

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7912 12V	.35
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3,579MHz	1.00
3,932MHz	1.00
4,000MHz	1.58
4,194MHz	1.35
6,000MHz	1.00
6,144MHz	1.25
6,400MHz	1.50
10,000MHz	1.50

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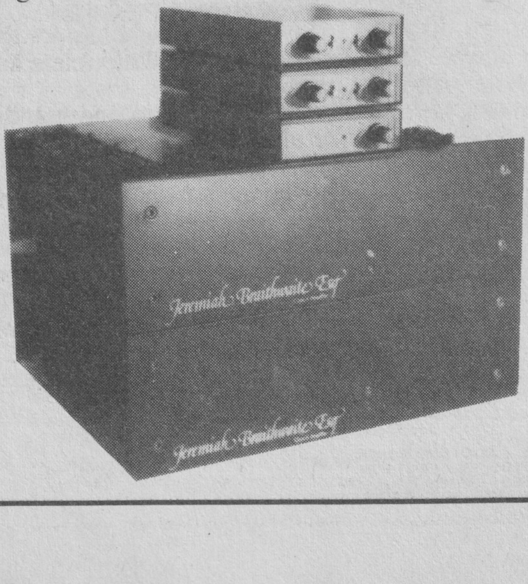

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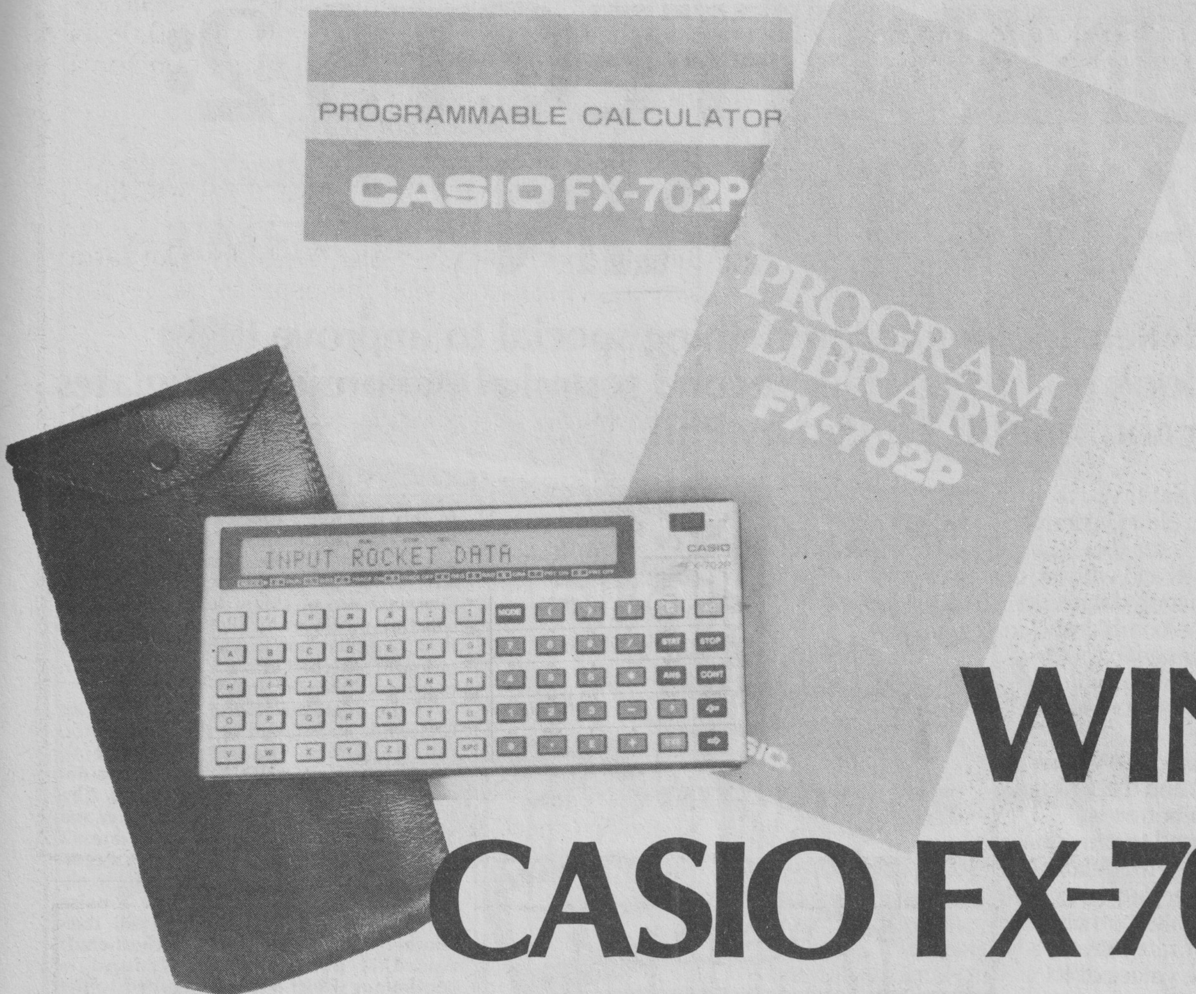

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If you've managed all that (hint — people who know BASIC well have an advantage), write the answer on the entry form (page 133) with your name and address and send it to us by April 30th 1982. Answers to six decimal places, please.

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1. Closing date is April 30th 1982, and all entries post-marked later than this date will be discounted.
2. The coupon provided in the magazine must be used. Photocopies are NOT acceptable.
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SOUND EFFECTS 2: STEAM TRAIN

Railway modellers looking for something special to improve their layout need look no further. Our second sound effect project simulates a steam train and whistle. Design by Phil Wait.

Aahh, the nostalgia! If you're young at heart, old in years, or both, then this is for you — a steam train (chuff-chuff) and whistle. The *electronic* construction details are given on page 50 in the bomb drop project; but for that *authentic* touch, deft constructors can also fashion a cow-catcher out of tinned copper wire to attach to the unit!

The chuff-chuff runs continuously once power is applied and the whistle sounds when the push-button is pressed. The VCO is used to provide the whistle while the SLF modulates the noise generator/filter output to produce the steam train's chuff-chuff sound. The chuff-chuff rate may be varied by changing the values of R1 and C1, while the chuff-chuff sound may be varied by changing the values of R2 and C2. For a special effect, you can control the chuff-chuff rate manually by replacing R1 with a 1M0 potentiometer.

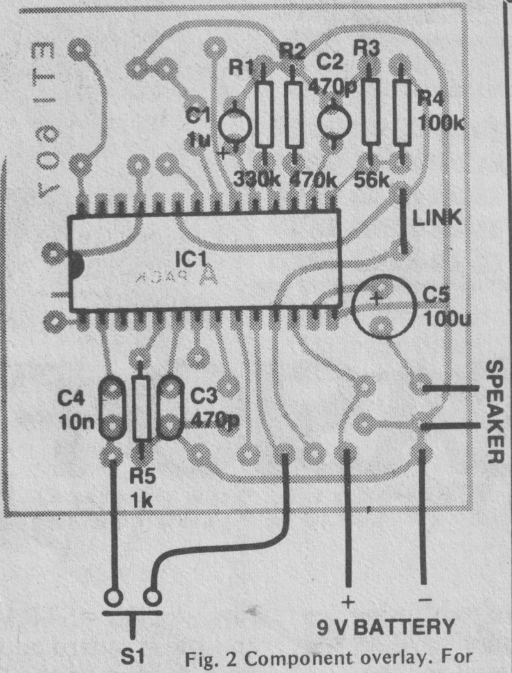

Fig. 2 Component overlay. For Buylines, see page 51.

HOW IT WORKS

In this unit the Noise Generator/Filter is employed to produce the basic 'steam engine' sound, this being modulated by the SLF to produce the 'chuff-chuff' so characteristic of steam locomotives. The whistle is produced by the VCO, which is set to a particular non-varying pitch, and the output is switched into the audio input pin to produce the whistle.

The broadband noise from the Noise Generator is modified by the Noise Filter, the frequency characteristics being determined by R5 and C3 connected to the Noise Filter Control pins (5 and 6). The Noise Filter Output is fed via the Mixer and the Envelope Generator (which doesn't function here) to the audio output stages. The SLF square wave output effectively modulates the noise to produce a noise burst followed by a silent period, then another noise burst. Thus the chuff-chuff sound is produced. This sound is continuous whilst power is applied to the unit.

A resistive divider, R3/R4, provides about 1V8 at the VCO frequency to a convenient pitch within its range, providing a suitable pitch for the whistle. The VCO output is coupled to the audio input (pin 10) via C4 and the push-button, PB1. When PB1 is pressed, the whistle is heard over the chuff-chuff sound.

The SLF frequency is determined by C1 and R1, while the combination of R2/C2 and the voltage on pin 15 determines the VCO frequency. Output to the loudspeaker is coupled via C5, a 100uF electrolytic capacitor.

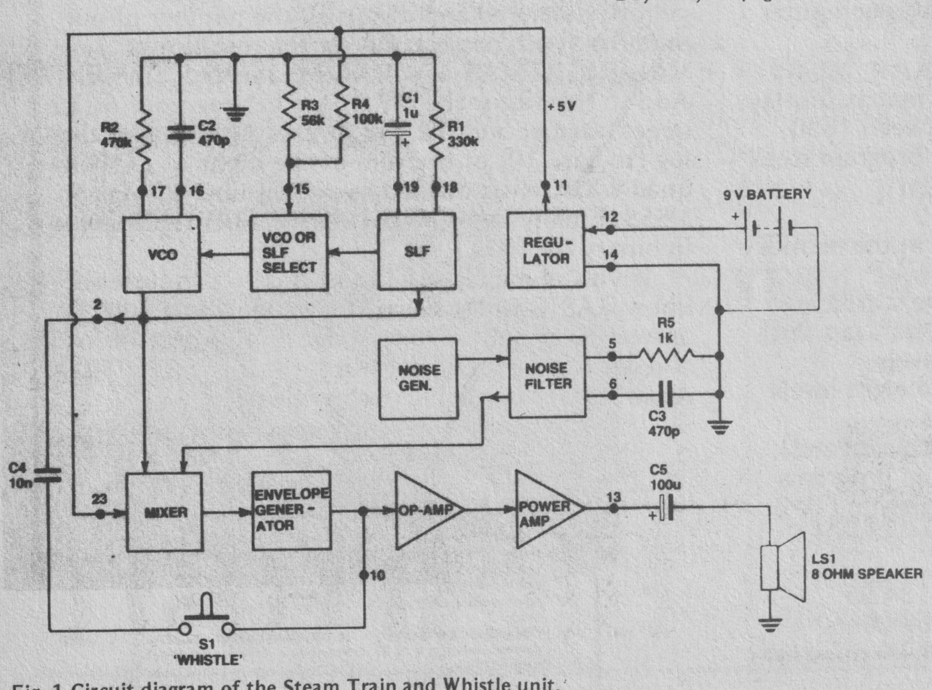

Fig. 1 Circuit diagram of the Steam Train and Whistle unit.

PARTS LIST

Resistors (all ¼ W, 5%)	
R1	330k
R2	470k
R3	56k
R4	100k
R5	1k0
Capacitors	
C1	1u0 16 V tantalum
C2, 3	470p ceramic
C4	10n ceramic
C5	100u 16 V PCB electrolytic
Semiconductors	
IC1	SN76488 (see Buylines)
Miscellanous	
PB1	SPST push-button switch

PCB (see Buylines); 50 mm diameter 8 ohm speaker; PP3 battery and clip.

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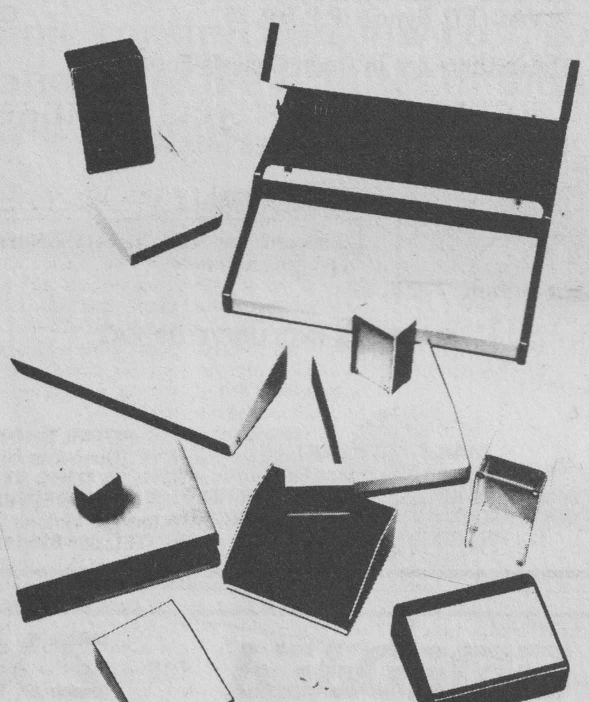

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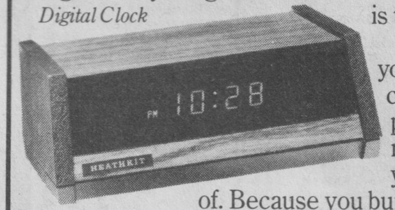

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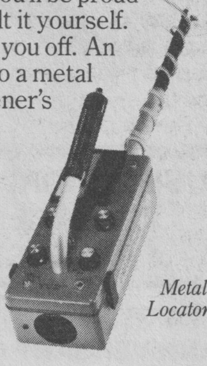

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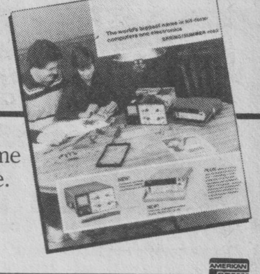

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GUITAR PRACTICE AMPLIFIER

Simple construction, low cost, good performance and super neighbour relations are the features of this project! Design and development by David Tilbrook.

This project has been designed to enable guitarists to put in long hours of practice and still keep that high power amp in the cupboard, where it belongs! It is a compact amp capable of about 7 W into a 4 ohm load. This is enough power for practice purposes and just think of the greatly improved relations you will have with your neighbours.

We were in a considerable quandary as to how to present the project, whether it should be done as a complete practice unit with inbuilt speaker or simply as an amplifier to be connected to an external speaker. Finally we chose a compromise. The PCB has been designed in such a way that it can be used as a totally self-contained unit. The heatsinks for the output stage have been mounted on the PCB so that the only components separate to the board are the power transformer, 240 volt power switch controls, input and output jacks. We have shown the project mounted in its own box with power transformer but it should be a simple matter to construct the whole unit inside a small loudspeaker cabinet.

The unit has two inputs so that two guitars can be mixed together using the relative settings of the two input level controls. A preamp output enables your main high power amp to be driven from the guitar practice amp using the practice amp as foldback.

We provided the PCB with the necessary circuitry for a battery input but you might elect not to use this feature. If so diode D8 and the battery switch can be omitted with points 'A' and 'C' connected together by a wire link.

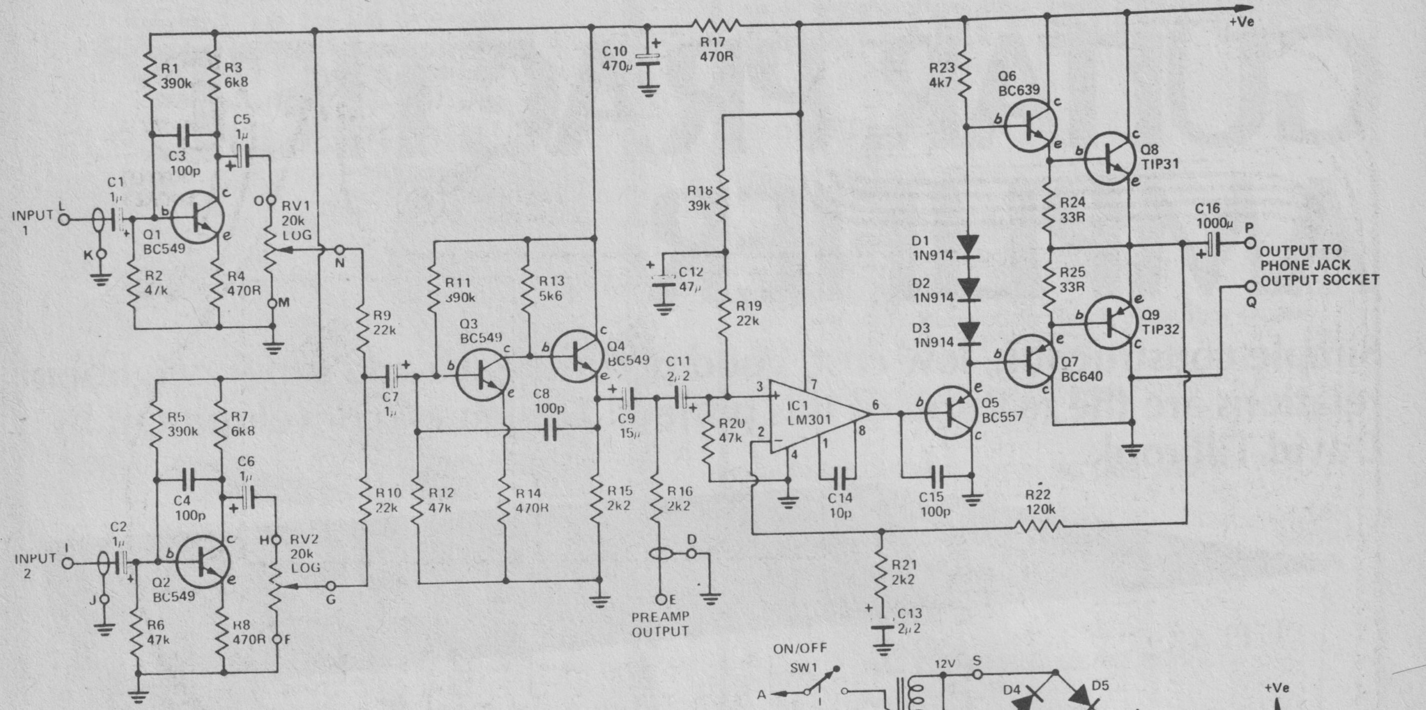
Construction

Construction of the project is reasonably simple since it is almost entirely devoted to construction of the PCB. Start as always by mounting the resistors and non-polarised capacitors. Mount the tantalum and electrolytic capacitors next, being careful to orient them correctly. These components could be irreparably damaged if inserted the wrong way around. Mount the LM301 IC, transistors and diodes, again being careful to insert these the correct way round.

Finally the output devices can be mounted. Although the transistors are in TO220 packages, our PCB is laid out to accept heatsinks drilled for TO3 transistors. The overlay and photograph should make the construction method clear. Cut the centre (collector) lead off. This lead is connected to the case of the transistor internally, so in this case, electrical connection is made through the mounting screw that also serves to hold the heatsink in place. Place the heatsinks on the PCB and secure with the lower nut and bolt (not used to mount the transistors). There is only one right way round. Bend the leads of the output transistors and, using a small amount of thermal compound, mount the transistors with the leads protruding through the PCB.

Secure each transistor with a nut and bolt through both the transistor 'flag' and heatsink. Use a star washer between the head of the bolt and the copper pad on the PCB to ensure good electrical contact. Now the base and emitter leads can be soldered to their pads.

The prototype unit was constructed in a steel box measuring



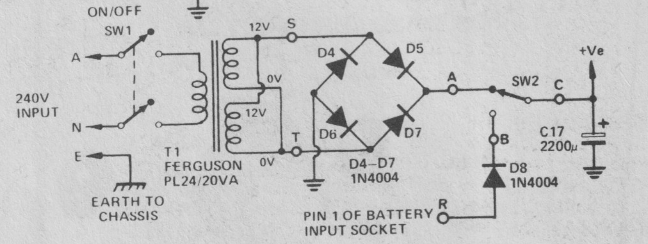


Fig. 1 Circuit diagram of the ETI Guitar Practice Amplifier. The amp may be powered by an external battery or from the mains, using the circuit on the right.

HOW IT WORKS

The two input stages formed around Q1 and Q2 are identical. Resistors R1, R2 and R4 form a very stable biasing configuration around Q1. The gain of this type of circuit is determined by the values of R3 and R4 (specifically, the gain is R3/R4). The load impedance on the output of the input stages is in parallel with R3, effectively decreasing the total value of impedance from collector to ground. Remember that, as far as signal is concerned, the positive supply rail is a short circuit to ground, since it is connected to ground through C17, a 2200uF capacitor. When all these factors are taken into account the gain of the first stage is about 10 since the impedance from collector to ground is about 4k7.

The signal, which should now be around 200 mV, is then applied to the input of the second stage through potentiometers RV1 and RV2. The 22k resistors R9 and R10 prevent the output of one of the stages being shorted to ground when the other is turned right down.

The second stage works in exactly the same manner as the input stages, resistors R11, R12 and R14 forming the bias network for Q3. The voltage present on the collector of Q3 is around 9 V which is approximately half the supply voltage. This is used to bias Q4 which is an emitter follower. This type of amplifier has no voltage gain but provides a low output impedance to drive the preamp output socket. Q3 has a gain of approximately 10. If the volume controls RV1 and RV2 are used in their middle positions, the voltage out will be around one tenth of the voltage at their inputs since these are logarithmic pots. So, the signal voltages into Q3 should be in the order of 20 mV. This will be amplified to a level of 200 mV and applied to the input of the power amp. The power amp has been designed to deliver full power with an input voltage of 300 mV, so the amp should be easily driven to full output with usable settings.

Since this is a guitar amplifier, it will spend most of its life hard into clipping. The output stage had to be robust! The basis of the output stage is the LM301 op-amp. This device gives all of the voltage gain in the power amp. The output IC1 is fed through a voltage follower Q5. This has no voltage gain and, like Q4, serves to decrease the impedance feeding the output stage. The three diodes, D1, D2 and D3, maintain 1V8 between the bases of Q6 and Q7. Each of these transistors will drop approximately 0V6 across their base-emitter junctions. This leaves a total of 0V6 to be dropped by the two 33R resistors, R24 and R25. Since these are of equal value they will each drop 0V3 and hold this voltage across the base-emitter junctions of the two output transistors Q8 and Q9. As these transistors require 0V6 to turn on they will remain off until the applied signal voltage causes the voltages on their bases to rise above 0V6. The extra 0V3 needed to turn on the output devices will be supplied by a mere 10 mA of current through the 33R resistors. Resistor R22 forms a feedback loop around the entire output stage to decrease distortion, stabilise the DC output voltage and set the overall gain of the power stage (a process too difficult to go into here).

The op-amp will at all times attempt to make the DC voltage at the output equal to that voltage set up on its positive input. This voltage is determined by the potential divider formed by R18, R19 and R20. Since this is also the main input to the power amp any noise which might be on the positive supply rail (and supplies can get very noisy sometimes!) will be communicated directly to the input of the power amp, only to be amplified and applied to the loudspeaker. Capacitor C12 prevents this from happening by bypassing to ground any noise above a frequency of around 0.1 Hz.

approximately 250 x 210 x 80 mm. Mount the pots and switches on the front panel, using the pot and switch nuts to secure the front escutcheon if you have one. Mount the output and battery input sockets on the rear panel. If you are using a battery input socket use something different to the output socket (which is usually a two-pin DIN socket or a 6.5 mm jack socket) to avoid confusion.

Mount the power transformer and make the 240 V connections. The mains lead should be terminated immediately inside the case into a terminal block and the earth lead secured firmly to the chassis by a solder lug bolted to the case using a star washer. This lead must be the longest. A length of 240 V cable should be used between the terminal block and the power switch. Wire the transformer to the power switch as shown in the circuit diagram, then wrap the whole switch with insulation tape or enclose in large diameter heat-shrink tubing so that no 240 V connection is exposed.

Finally, the fully-loaded PCB can be secured into the case using short metal spacers. If Veropins are used, all the connections to the board can be made after the board has been mounted. Connect the front panel controls, rear panel sockets and input sockets, using short lengths of shielded cable to make the connections to the two inputs and preamp output.

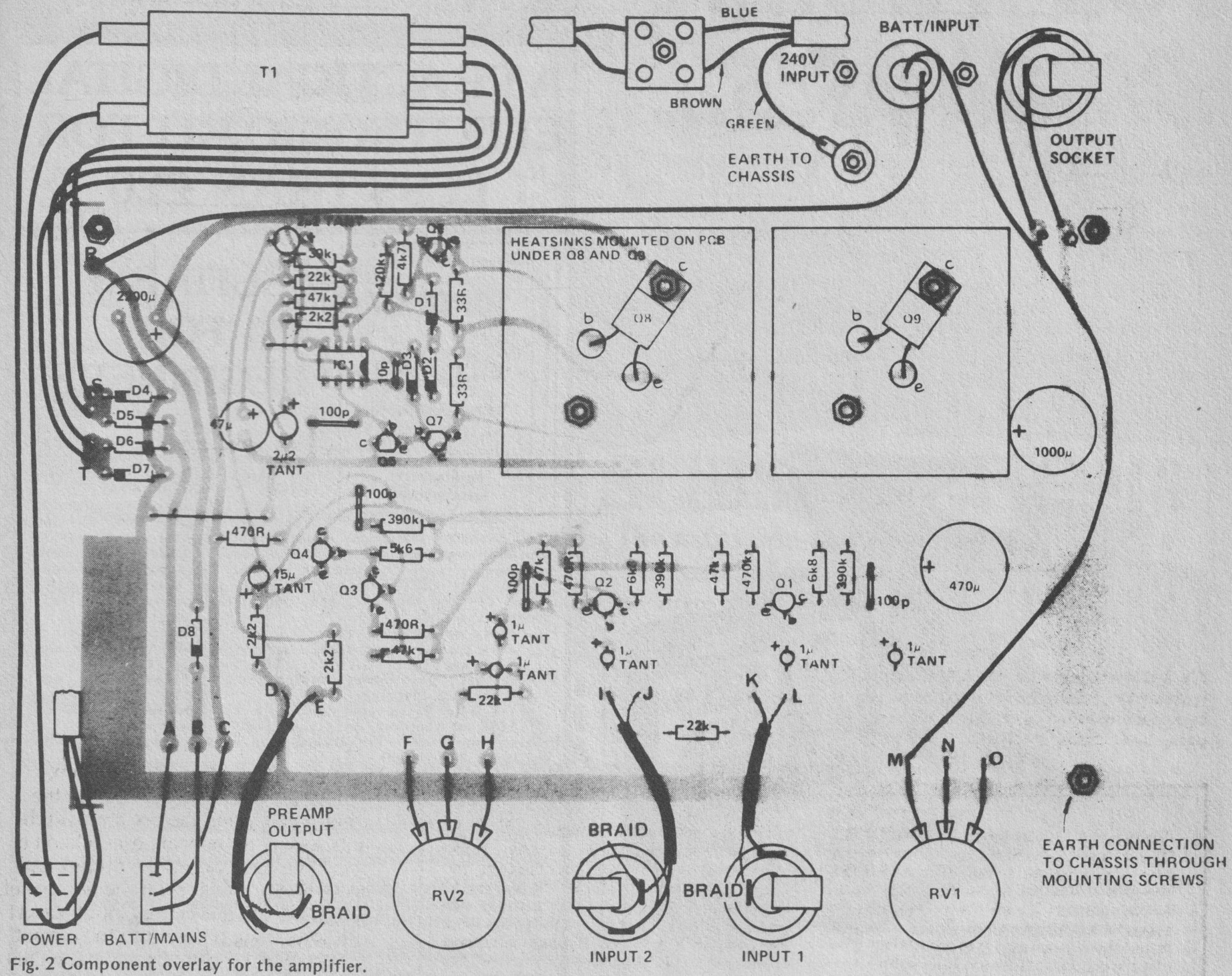


Fig. 2 Component overlay for the amplifier. The original design used a BC639/BC640 complementary pair for Q6 and Q7, and these are shown on the overlay, but they may prove hard to obtain. Consequently the PCB we will be supplying is laid out for a BC140/BC160 pair, which have different pad layouts — the b,c and e pads are etched onto the board for your guidance.

Powering Up

Make a final check of the wiring and PCB. If all is well, apply power. A slight turn-on thump should be heard at the moment of turn-on. If the 'Input 1' volume control is now wound up, some hiss should be heard from the loudspeaker. Do the same check on the other input. There is no set-up procedure since the power amp stage is operating in class B and requires no bias adjustment.

BUYLINES

Lots of nice, standard, easy-to-obtain components in this project, so you shouldn't encounter any problems with supply. The PCB will be available fro our PCB Service at the price listed on page 44.

PARTS LIST

Resistors (all ½W, 5%)

R1,5,11	390k
R2,6,12,20	47k
R3,7	6k8
R4,8,14,17	470R
R9,10,19	22k
R13	5k6
R15,16,21	2k2
R18	39k
R22	120k
R23	4k7
R24,25	33R

Potentiometers

RV1,2	22k logarithmic

Capacitors

C1,2,5,6,7	1u0 35 V tantalum
C3,4,8,15	100p disc ceramic
C9	15u 16 V tantalum
C10	470u 25 V PCB electrolytic
C11,13	2u2 35 V tantalum
C12	47u 25 V PCB electrolytic
C14	10p disc ceramic
C16	1000u 25 V PCB electrolytic
C17	2200u 25 V PCB electrolytic

Semiconductors

IC1	LM301
Q1-4	BC549 or BC109
Q5	BC557 or BC179
Q6	BC140
Q7	BC160
Q8	TIP31
Q9	TIP32
D1-3	1N914
D4-8	1N4004

Miscellaneous

SK1-4	mono jack sockets
SK5	DIN socket (or other type — see text)
SW1	DPDT toggle switch (mains rated)
SW2	DPST toggle switch

Transformer (12-0-12-0, 20 VA); TO3 type PCB-mounting heatsinks; PCB (see Buylines); case to suit; mounting hardware.

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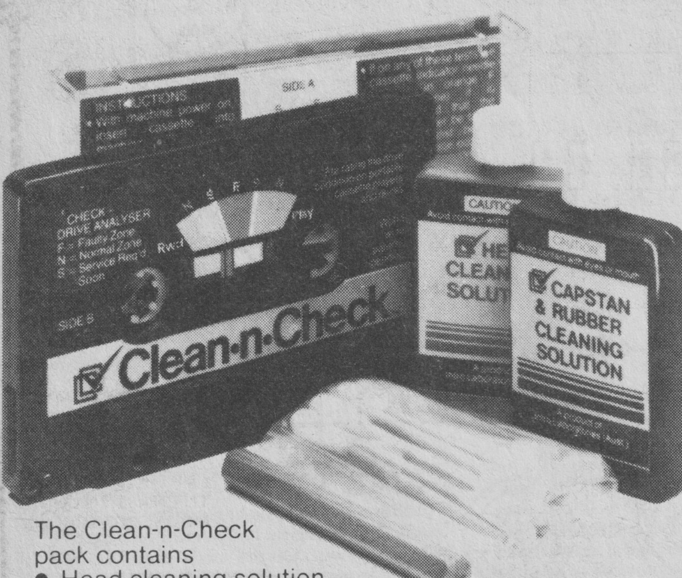

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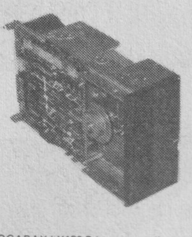

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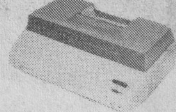

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BLACK RIBBONS FOR TELEPRINTERS **75p each or 6 for £4.**
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DON'T TAKE CHANCES Use the proper EHT Cable **10p metre. £7.50 100 metres** P&P £2.
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AM 0.45-225MHZ FM 20-100MHZ
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TYPE TU-2 Testing	£25
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20HZ-200KHZ. Portable. As new.
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Solid State. Video in. Int & Ext Sync. **£75 each.**

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AS ABOVE less transformer **240p**
PCB for above or 12V or 15V **100p**
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33pF to 50,000pF . . . . **.3p**
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VERO BOARD (0.1" copper clad)
2.5 × 5" **60p** 3.75" × 5" **100p**
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2V7 to 33V . . . . **.6p**
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600V: 10A **50p** 15A **55p** 30A **65p**
High performance glass passivated for high voltage isolation. By THYROTEK CORP of Texas in 3 pin pressfit metal case with superior spec to plastic ones.
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709-8	20p
710-14	20p
741-8	20p
747-14	40p
748-8	25p
AY-1-1313	750p
AY-1-5050	110p
AY-3-1270	950p
AY-3-8912	710p
AY-5-1224A	265p
AY-5-4007D	510p

CA3018H	50p
CA3019	80p
CA3028AH	50p
CA3046N	30p
CA3048	245p
CA3054	40p
CA3080	65p
CA3090AQ (star buy)	70p
CA3130E	90p
CA3140	45p
CA3160E	110p
ICL7106	850p

LF351N	45p
LF356N	90p
LM10C	460p
LM301AN	25p
LM308N	30p
LM311	80p
LM318H	92p
LM318N	100p
LM324N	40p
LM339N	46p
LM348N	46p
LM380N	65p
LM381N	100p
LM382N	90p
LM733	80p
LM1458N	35p
LM1830	170p
LM2917	220p
LM3900N	40p
LM3909N	75p
LM3914	200p
LM3915	240p
LM13600	140p
MC1310N	75p
MC1495L	400p
MC1496P	70p
MK50398	730p
ML922	485p
ML926	160p
ML928	160p
ML929	155p
NE531	100p
NE555	22p
NE562	400p
NE566	100p
NE567	160p
SN76115AN	50p
TAA621	280p
TBA641B	125p
TBA651	100p
TBA800	65p
TBA820	80p
TDA1004	335p
TDA1008	355p
TDA2020	250p
TL072	57p
TL074	140p
TL081	30p
TL082	50p
UAA170	190p
ZN424E	150p

DIAC: ST2 **20p**

THYRISTORS

300V:4A (MOTOROLA)	18p
400V:5A (C106D)	35p
100V:12A (TEXAS INT)	20p
400V:8A (MOTOROLA)	36p

OPTO ELECTRONICS

DL704	70p
DL707	70p
FND500	60p

MARCH SALE
Send SAE for bulk offers

ORP12	80p
TIL38 (12mW IR)	18p

LEDS

3mm clip	3p
5mm clip	3p
3mm & 5mm RED LED	10p
GREEN LED	11p
YELLOW LED	11p
RECT GREEN	13p

VOLTAGE REGULATORS

500mA:	
78M12 +	20p
79M05 —	20p
79M12 —	20p
79M24 —	20p
1 Amp:	
7805	55p
7805/12	55p
7815	58p
7818	52p
7905	58p
7912	60p
7915	62p
7918/24	50p
1.5 Amp	
7805	70p

BRIDGE RECTIFIERS

W02M	16p
W06M	17p
1A/50V	18p
1A/200V	18p
1A/400V	20p
1A/600V	20p
2A/50V	20p
2A/100V	20p
3A/600V	33p

DIL SOCKETS

8 pin	6p
14 pin	10p
16 pin	11p
18 pin	16p
22 pin	16p
24 pin	18p
28 pin	24p
40 pin	24p

DIODES

OA91	7p
OA200/2	5p
1N916	4p
1N4148	4p
1N4001	4p

1N4005	5p
1N5400	11p
1N5401	12p
1N5402	13p
1N5404	14p

CMOS

4000	13p
4001B	14p
4002	13p
4006B	45p
4007	11p
4008	56p
4009	28p
4010B	33p
4011B	14p
4012	17p
4013B	28p
4014	58p
4015B	60p
4016	20p
4017	35p
4019	33p
4020B	65p
4021	56p
4022	37p
4023	15p
4025	14p
4027	30p
4028	45p
4029	65p
4030	18p
4035	92p
4041	75p
4042	55p
4043	70p
4044	40p
4047	90p
4048	45p
4049	28p
4050B	32p
4066	30p
4068	20p
4069	14p
4070B	17p
4071	20p
4072/3	23p
4081	22p
4082	24p
4086	66p
4510	80p
4511B	70p
4516	82p
4518	65p
4520/8	82p

TTL "LS"

LS00/1	12p
LS02/3	12p
LS04	13p
LS05/8	14p
LS10	14p
LS11/12	15p
LS13	24p
LS14	36p
LS20	14p
LS21/27	15p
LS30	14p
LS32	17p
LS42	35p
LS47	48p
LS48	45p
LS73	20p
LS74	18p
LS75	25p
LS76	26p
LS78	22p
LS86	21p
LS90	40p
LS93	28p
LS95	50p
LS109	30p
LS122	35p
LS123	40p
LS154	40p
LS157	35p
LS163	42p
LS221	52p
LS251	50p
LS253	50p
LS279	30p

TTL "N"

7400/1	11p
7402	11p
7403	10p
7404	9p
7405	11p
7406	15p
7407	24p
7408	16p
7409	13p
7410	11p
7411	17p
7412	15p
7413	19p
7414	44p
7416	18p
7417	16p
7420	9p
7421/3	23p
7425/6	21p
7427	16p
7428	35p
7430	13p
7432	19p
7433	35p
7437	14p
7438	12p
7440	11p
7441	58p
7442	25p
7443	35p
7444	72p
7445	38p
7446	72p
7447A	35p
7448	35p
7450	11p
7451	6p
7453	6p
7454	13p
7460	7p
7470	22p
7472	25p
7473	14p
7474	16p
7475	23p
7476	18p
7480	25p
7482	56p
7483	45p
7486	20p
7489	110p
7490	22p
7491	38p
7492/3	30p
7494	40p
7495	35p
7496	38p
7497	166p
74100	70p
74105	46p
74107	18p
74109	19p
74110	52p
74118	90p
74121	21p
74122	30p
74123	46p
74125	46p
74126	38p
74132	58p
74141	48p
74145	46p
74147	130p
74150	64p
74151	45p
74153	48p
74154	40p
74155	50p
74156	33p
74157	35p
74161	29p
74162	57p
74163	41p
74164	38p
74165	50p
74167	70p
74173	60p
74174	46p
74175	46p
74177	37p
74180	30p
74181	99p
74182	40p
74184	70p
74185	115p
74190	42p
74191	48p
74192	40p
74193	46p
74194/5	64p
74197	44p
74198	99p
74199	60p

TRANSISTORS

AC127	25p
AC128	22p
AC128/176 mt. pair	23p
AC141/2	15p
AC151	17p
AC153	20p
AC176	20p
AC187	12p
AC187K	13p
AC188	20p
AD149	37p
AF118	30p
AF124/5	40p
AF126	25p
AF139	35p
AF186	40p
ASY54/5	18p
BC107	10p
BC108/9	10p
BC113	6p
BC117/9	10p
BC113	6p
BC117	10p
BC119	10p
BC142	23p
BC143	23p
BC147	6p
BC148	7p
BC149	7p
BC157	9p
BC158	6p
BC159	9p
BC167	10p
BC168	8p
BC170	6p
BC172	5p
BC173	7p
BC177	10p
BC178	13p
BC179	12p
BC182	9p
BC182L	9p
BC184L	9p
BC186	19p
BC187	15p
BC207	7p
BC212	9p
BC212L	9p
BC213	9p
BC213L	9p
BC214	9p
BC214L	9p
BC237	7p
BC238	5p
BC261B	7p
BC301	25p
BC328	7p
BC338	18p
BC477	18p
BC547/8	7p
BC549	9p
BC557/8	7p
BC559	13p
BCY30	40p
BCY34	40p
BCY59	15p
BCY70	13p
BCY71	14p
BCY72	14p
BD115	27p
BD121	46p
BD123	50p
BD131/2	35p
BD135/6	25p
BD137/8	25p
BD139	35p
BD140	35p
BF167	15p
BF173	15p
BF178	30p
BF180	22p
BF181	7p
BF183	29p
BF184	21p
BF185	15p
BF194	12p
BF195	9p
BF196	7p
BF197/8	10p
BF200	23p
BF244C	15p
BF257	14p
BF258	21p
BF259	15p
BFR39	18p
BFR40	18p
BFR80	20p
BFX29	25p
BFX84	23p
BFX86	18p
BFX87	23p
BFX88	22p
BFY50	20p
BFY51	15p
BFY52	18p
BFY53	10p
BRY39	30p
BSX20	10p
BU205	105p
BU208	115p
MJ2955	90p
MJE340	33p
MPF104	40p
MPF105	40p
MPF106	40p
OC28/35	40p
OC72	10p
TIP29	25p
TIP29B	28p
TIP30	25p
TIP30B	28p
TIP31	20p
TIP31A	22p
TIP32	35p
TIP33C	35p
TIP34A	46p
TIP35B	115p
TIP36A	127p
TIP36B	135p
TIP41A	50p
TIP42A	50p
TIP2955	58p
TIP3055	52p
ZTX107/8	10p
ZTX109	10p
ZTX300	9p
ZTX301/2	9p
ZTX303	10p
ZTX304	20p
ZTX311	16p
ZTX341	18p
ZTX500/1	11p
ZTX502	16p
ZTX503	14p
ZTX504	19p
2N697/8	20p
2N706	9p
2N914	14p
2N918	16p
2N1131	11p
2N1132	13p
2N1304	23p
2N1306	23p
2N1308	30p
2N1613	21p
2N2217	18p
2N2222A	15p
2N2369	14p
2N2484	18p
2N2646	40p
2N2904	17p
2N2906/7	17p
2N2926G	10p
2N3053	25p
2N3055	44p
2N3702 to 2N3711	.8p
2N3773	150p
2N3819	21p
2N3820	35p
2N3823	52p
2N3866	40p
2N3903	11p
2N3904	11p
2N3906	11p
2N4037	35p
2N4058 to 2N4061	.6p
2N5458	40p
2N5459	35p
2N6027	18p
3N128 (star buy)	20p

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TBA641B 10 for **£11**
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4069A 20 for **220p**

7447A 20 for **660p**
74163 20 for **700p**
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POTENTIO-METERS (with 2A/250V DP switch) Linear: 47K 470K Log: 5K 22K 47K 100K 5 for **100p**

SLIDE SWITCH 1A/250V 10 for **40p** 3A/50V 10 for **80p**

CERMET 100K LIN 10 for **140p**

PRESETS (standard) 100R-H, 200R-V 1K5-H, 2K2-H 4K7-V, 10K-H 250K-V, 500K-H 1M-H, 2M-H 10 for **30p**

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'D' U2 4AH 1.2V	£2.52
'PP3' .075AH 1.2V	£3.13
CHARGER for all types	£5.22

BRIDGES MDA100 **32p** PM7A2 **64p** WOO5 **25p** WO2/4 **26p** 5SB40 **48p**

ZENERS
BZY88 3v to 18v 5p
BZX61/85 1W 3v3 to 33v 7p
5W 10W on request

ELECTROLYTIC TOL +10%-50% IN MFDS

TUBULAR 63v AXIAL	mm	PLUG IN	LEADS 7x.5mm PCM 5mm	
8p		2.2/63v	11x5	3p
1	13x6	4.7/63v	11x6	5p
2.2	13x6	10/63v	12x8	7p
3.3	13x6	22/35v	13x8	5p
4.7	13x6	47/35v	12x10	5p
6.8	13x7	100/25v	13x10	5p
10p		220/35v	17x10	9p
10	19x7	470/6v3	20x10	11p
22	19x9	1000/100	TAGS	39p
47	19x10	1500/6v3	25 × 15	17p
100	31x13			
220	31x13			

BUZZER 12V PVC **60p**

FUSES 20mmQB 100mA 500mA 1A/2A **6p**

PCB FUSE CLIPS **2p**

CERAMIC 5mm 10% 100v 10PF - 3K3PF, E6 ONLY. **5p**

POLYESTER PLUG IN BOX STYLE
TOL 10% BY EVOX. MULL. PLES ETC.

All at 4p	PCM	All at 6p	PCM
.001/400v	10	.22/250v	15
.0022/400v	10	.33/100v	15
.0033/400v	10	.47/250v	22
.0047/400v	10	.68/100v	15
.01/630v	10	**All at 12p**	
.022/250v	10	1.0/100v	15
.033/250v	10	1.5/100	22
.047/100v	10	2.2/100	22
.068/100v	10	**All at 18p**	
.1/250v	10	3.3/100v	22
In MFDS sizes in mm		4.7/100v	27

LEDS

.125" TIL209	
Green	12p
Red	7p
Yellow	13p
.2" TIL220	
Green	12p
Red	10p
Yellow	13p

BIG DISCOUNTS FOR BULK

.2 CLIPS 5p
TIL111 57p

POLYESTER AXL 10%

5p	9p
.01 400v	.33 100v
.022 250v	.47 250v
.047 250v	.68 400v
.1 160v	1.0 250v
.22 400v	1.5 100v

TANT BEAD 5mm 20%

Val	V		Val	V	
.1	35	7p	4.7	25	12p
.22	35	8p	10	25	24p
.47	35	9p	22	35	30p
1.0	35	12p	100	10	34p
2.2	20	12p	150	16	40p

DIODES by ITT, MULL, SESCOSEM, TEXAS (CODED)

AAZ15	9p	OA47	5p	IN916	3p
BAX13/16	3p	OA90/91	6p	IN4001/2	2½p
BAY71	9p	OA200/2	11p	IN4004	3½p
BY127	7p	RPG10B	3p	IN4007	6p
BY206	19p	S2BN71	90p	IN4148	2p
BY255	9p	IAV30	9p	IN5397	7p
BYX10	30p	IN270	6p	IN5401/2	11p
CV8790	5p	IN914	2p	IN5408	13p

ICs DIL PINNING (—) LM AND CA

				747 (14)	37p
301 (8)	22p	555 (8)	19p	1310 (14)	49p
308 (8)	42p	556 (14)	42p	1458 (8)	27p
311 (8)	41p	565 (14)	95p	3046 (14)	59p
324 (14)	35p	567 (8)	95p	3080 (8)	83p
339 (14)	44p	709 (14)	21p	3140 (8)	92p
348 (14)	56p	710 (14)	32p	3900 (14)	43p
380 (14)	65p	725 (8)	£1.35	3914 (18)	£2.35
381 (14)	84p	741 (8)	15p	13600 (16)	99p

ICs DIL PINNING (—) MISC

TLO81P (8)	50p	2102AN 450	80p	6821P (40)	£1.68
TLO82P (8)	98p	2114N 200	£1.20	6850P (24)	£1.68
LF351 (8)	64p	4116 200	90p	6852 (24)	£2.45
LF353 (8)	98p	8116 450	£1.20	ICM7555 (8)	92p
ZN414 (3)	£2,34	6800P (40)	£2.87	8035 (40)	£2.75
ZN425 (16)	£3.40	6802P (40)	£5.81	8085A (40)	£5.75

ICs LPS 74LS — — N

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02	12p	90	30p
04	12p	109	24p
05	12p	132	44p
08	14p	138	36p
10	12p	240	76p
14	36p	244	78p
27	14p	367	38p
30	12p	374	72p
33	16p		
51	14p		

CMOS BUFF 40 — — N

01	12p	16	34p	29	48p
02	12p	17	48p	40	48p
06	48p	18	48p	41	52p
07	16p	20	54p	42	52p
08	52p	21	54p	46	80p
11	16p	22	54p	49	28p
12	20p	23	16p	60	52p
13	34p	24	42p	66	34p
14	48p	25	12p	69	16p
15	48p	27	38p	81	20p
		28	48p	93	38p

TTL 74 — — N

00 to 40	19p
42	24p
47	38p
51	19p
70	17p
86	17p
132	69p
193	96p
194	38p
197	42p
393	38p

SOCKETS GOLD T.I. 8 PIN **7p.** 14 PIN **8p.** 16 PIN **9p**
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BC108/B	12p	BFY50/51	19p	2N1711	19p
BC109	10p	BRY39	24p	2N2218/19	15p
BC109C	12p	BSW67/68	29p	2N2222A	12p
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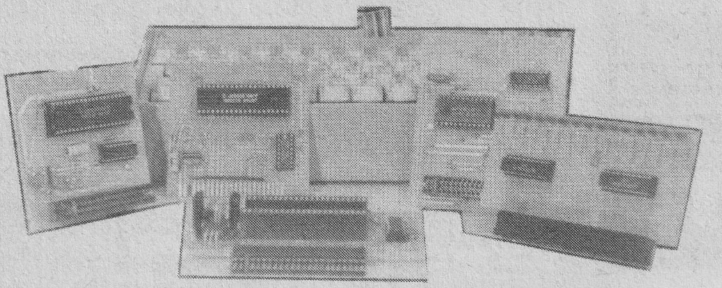

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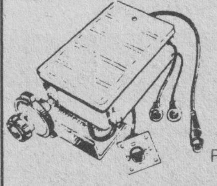

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	1X014	18 + 18	0 83		
	1X015	22 + 22	0 68		
	1X016	25 + 25	0 60		
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	2X011	9 + 9	2 77		
	2X012	12 + 12	2 08		
	2X013	15 + 15	1 66		
	2X014	18 + 18	1 38		
	2X015	22 + 22	1 13		
	2X016	25 + 25	1 00		
	2X017	30 + 30	0 83		
	2X028	110	0 45		
	2X029	220	0 22		
	2X030	240	0 20		
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	3X011	9 + 9	4 44		
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	3X014	18 + 18	2 22		
	3X015	22 + 22	1 81		
	3X016	25 + 25	1 60		
	3X017	30 + 30	1 33		
	3X028	110	0 72		
	3X029	220	0 36		
	3X030	240	0 33		
120 VA 90 × 40mm 1 2 Kg Regulation 11%	4X010	6 + 6	10 00	£7 55 + £1 43 P/P	£6 38 + £1 43 P/P
	4X011	9 + 9	6 66		
	4X012	12 + 12	5 00		
	4X013	15 + 15	4 00		
	4X014	18 + 18	3 33		
	4X015	22 + 22	2 72		
	4X016	25 + 25	2 40		
	4X017	30 + 30	2 00		
	4X018	35 + 35	1 71		
	4X028	110	1 09		
	4X029	220	0 54		
	4X030	240	0 50		
160 VA 110 × 40mm 1 8 Kg Regulation 8%	5X011	9 + 9	8 89	£9 92 + £1 43 P/P	£8 44 + £1 43 P/P
	5X012	12 + 12	6 66		
	5X013	15 + 15	5 33		
	5X014	18 × 18	4 44		
	5X015	22 + 22	3 63		
	5X016	25 + 25	3 20		
	5X017	30 + 30	2 66		
	5X018	35 + 35	2 28		
	5X026	40 + 40	2 00		
	5X028	110	1 45		
	5X029	220	0 72		
	5X030	240	0 66		

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE inc VAT	PRICE ex VAT
225 VA 110 × 45mm 2 2 Kg Regulation 7%	6X012	12 + 12	9 38	£11 83 + £1 73 P/P	£10 06 + £1 73 P/P
	6X013	15 + 15	7 50		
	6X014	18 + 18	6 25		
	6X015	22 + 22	5 11		
	6X016	25 + 25	4 50		
	6X017	30 + 30	3 75		
	6X018	35 + 35	3 21		
	6X026	40 + 40	2 81		
	6X025	45 + 45	2 50		
	6X033	50 + 50	2 25		
	6X028	110	2 04		
	6X029	220	1 02		
	6X030	240	0 93		
300 VA 110 × 50mm 2 6 Kg Regulation 6%	7X013	15 + 15	10 00	£13 67 + £1.73 P/P	£11 66 + £1.73 P/P
	7X014	18 + 18	8 33		
	7X015	22 + 22	6 82		
	7X016	25 + 25	6 00		
	7X017	30 + 30	5 00		
	7X018	35 + 35	4 28		
	7X026	40 + 40	3.75		
	7X025	45 + 45	3 33		
	7X033	50 + 50	3 00		
	7X028	110	2 72		
	7X029	220	1 36		
	7X030	240	1 25		
500 VA 140 × 60mm 4 Kg Regulation 4%	8X016	25 + 25	10 00	£18 17 + £2.05 P/P	£15 53 + £2.05 P/P
	8X017	30 + 30	8 33		
	8X018	35 + 35	7 14		
	8X026	40 + 40	6 25		
	8X025	45 + 45	5 55		
	8X033	50 + 50	5 00		
	8X042	55 + 55	4 54		
	8X028	110	4 54		
	8X029	220	2 27		
	8X030	240	2 08		
625 VA 140 × 75mm 5 Kg Regulation 4%	9X017	30 + 30	10.41	£25 10 + £2 20 P/P	£21 54 + £2 20 P/P
	9X018	35 + 35	8 92		
	9X026	40 + 40	7 81		
	9X025	45 + 45	6 94		
	9X033	50 + 50	6 25		
	9X042	55 + 55	5 68		
	9X028	110	5 68		
	9X029	220	2 84		
	9X030	240	2 60		

IMPORTANT: Regulation — All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

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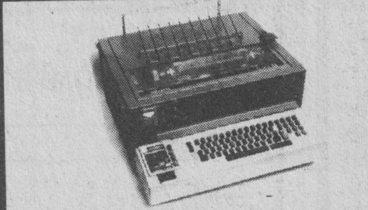

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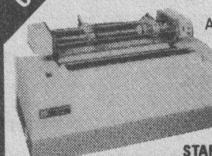

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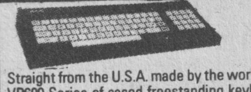

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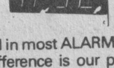

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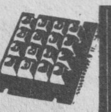

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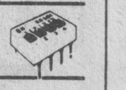

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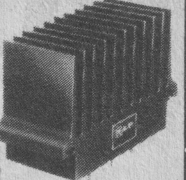

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HY 120	60w/4-8Ω	0.01%	<0.006%	±35±40	120×78×40	410	£20.10	£17.48
HY 200	120w/4-8Ω	0.01%	<0.006%	±45±50	120×78×50	515	£24.39	£21.21
HY 400	240w/4Ω	0.01%	<0.006%	±45±50	120×78×100	1025	£36.60	£31.83

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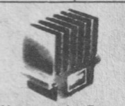

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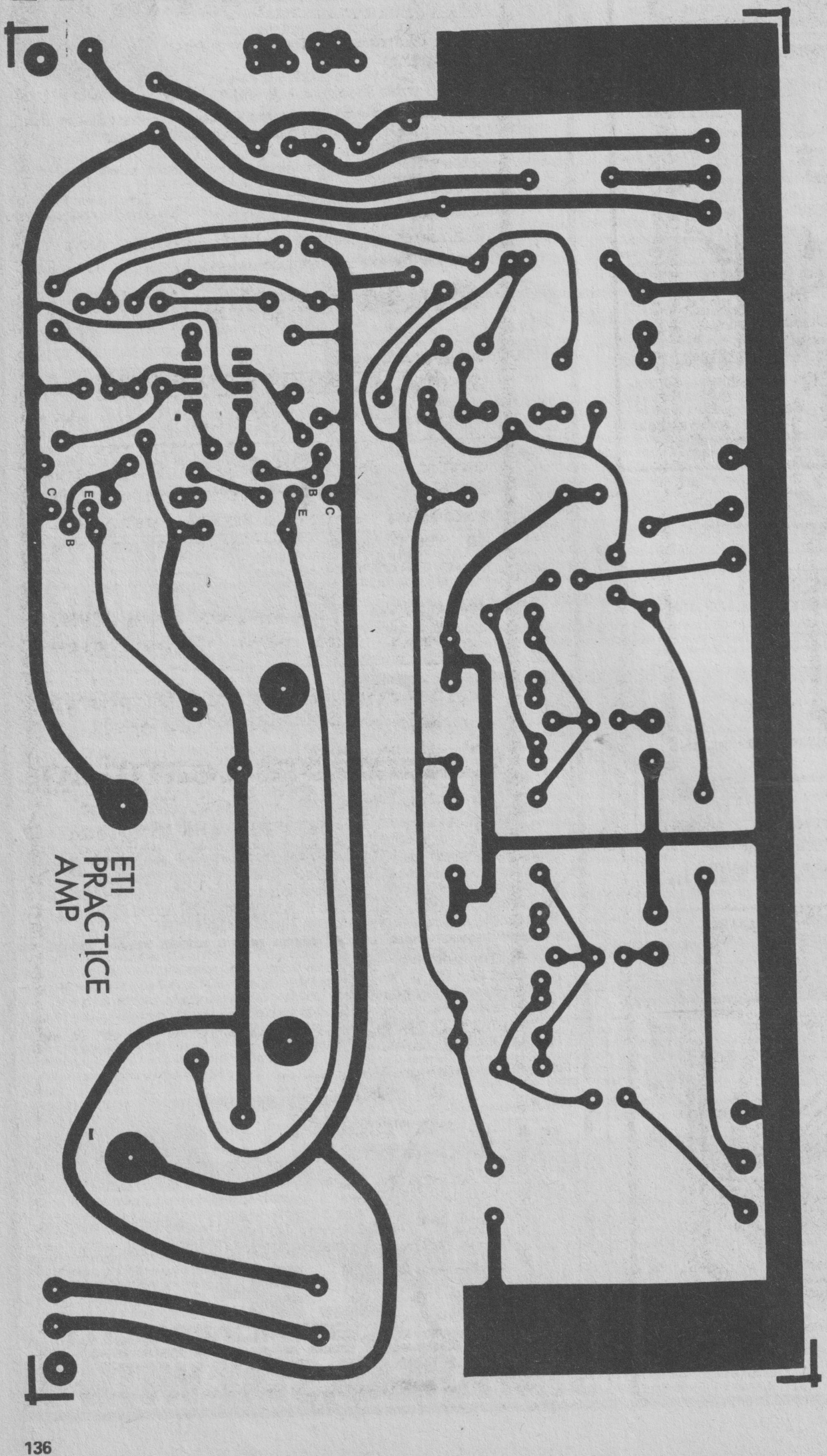
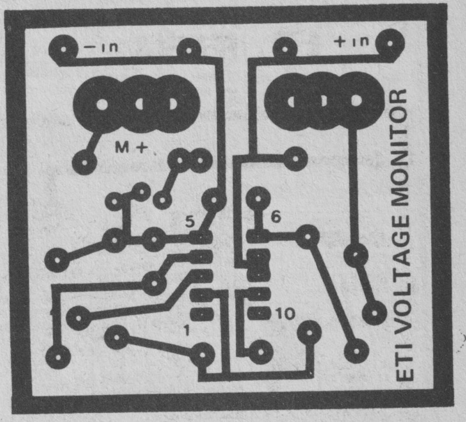
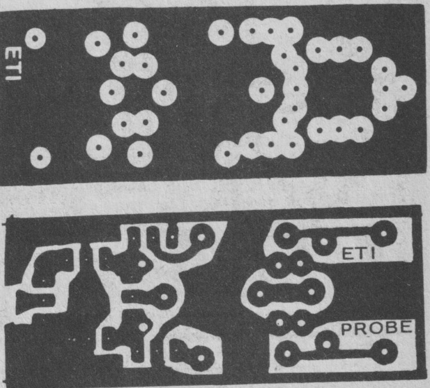
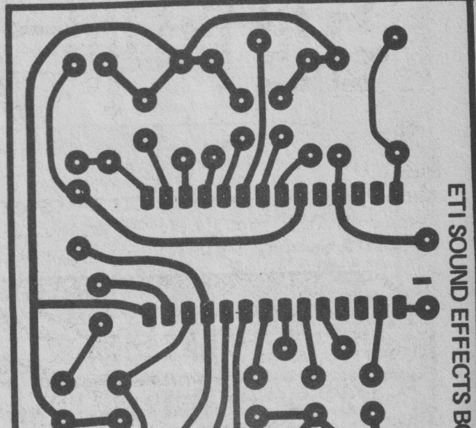




Above: the PCB for the Voltage Monitor.



Above: the two foils for the double-sided 100 MHz High Impedance Probe PCB.



Above: the board for the two sound effects projects.

Left: the board for the Guitar Practice Amplifier. Please note the alteration to the pad layout for Q6 and Q7.

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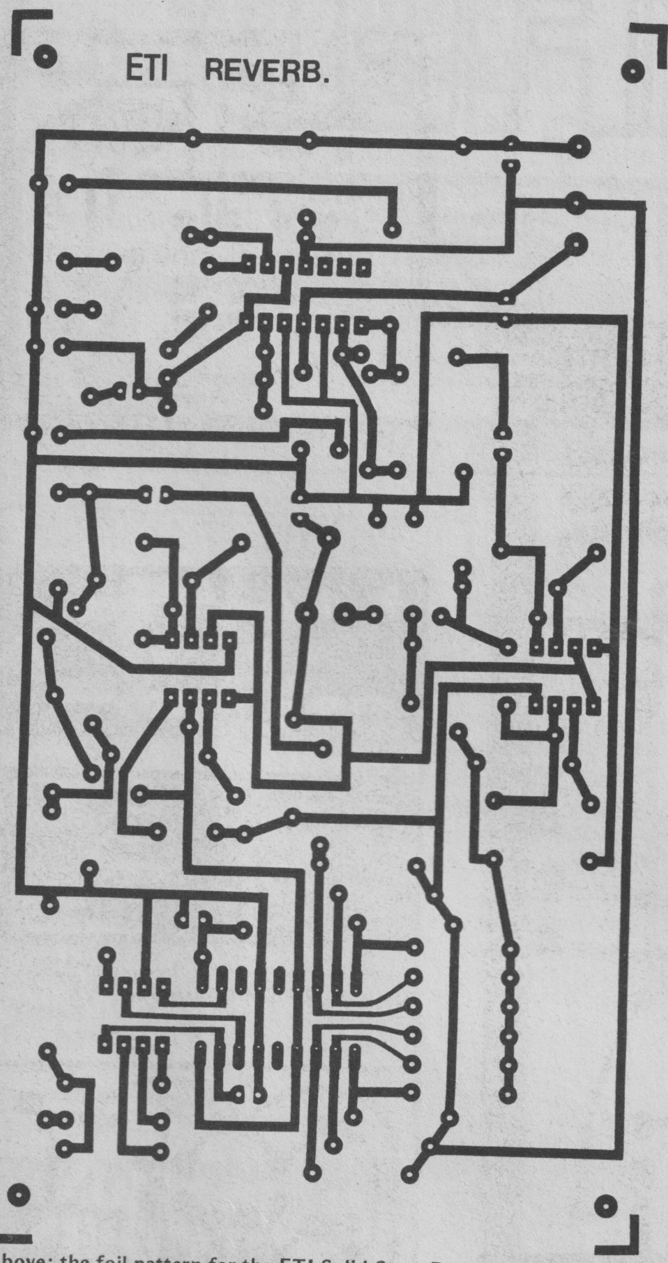
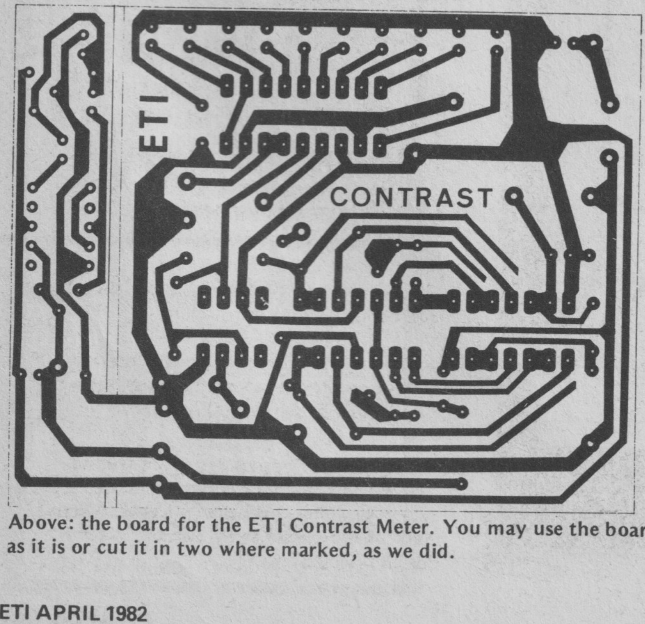
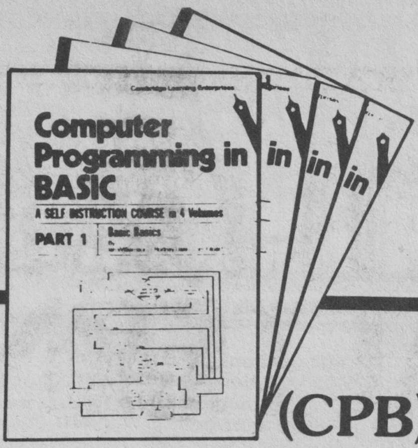


Above: the foil pattern for the ETI Solid State Reverb unit. Commercial firms should note that this board is the copyright of Digisound, and may not be reproduced for sale.



Above: the board for the ETI Contrast Meter. You may use the board as it is or cut it in two where marked, as we did.



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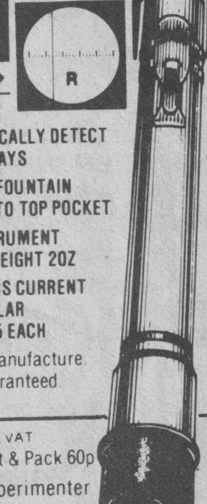

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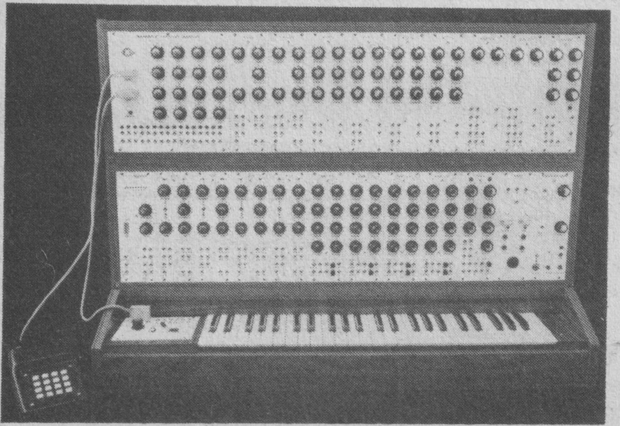

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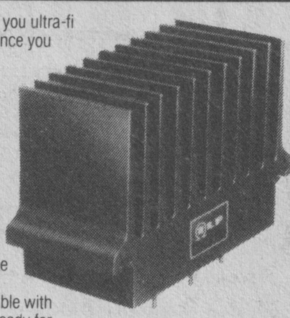

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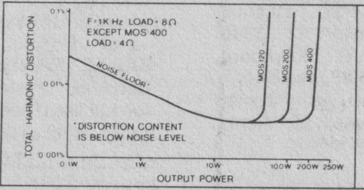

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Input impedance, all models 100K ohm
Input sensitivity, all models, 500 mV
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MOSFET Ultra-Fi, with heatsinks

Model No.	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	I.M.D. 50Hz/7kHz 4.1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex. VAT
MOS 120	60w/4-8Ω	<0.005%	<0.006%	±45±50	120×78×40	420	£29.76	£25.88
MOS 200	120w/4-8Ω	<0.005%	<0.006%	±55±60	120×78×80	850	£38.48	£33.46
MOS 400	240w/4Ω	<0.005%	<0.006%	±55±60	120×78×100	1025	£52.20	£45.39

MOSFET Ultra-Fi without heatsinks

MOS 120P	60w/4-8Ω	<0.005%	<0.006%	±45±50	120×26×40	215	£26.82	£23.32
MOS 200P	120w/4-8Ω	<0.005%	<0.006%	±55±60	120×26×80	420	£32.81	£28.53
MOS 400P	240w/4Ω	<0.005%	<0.006%	±55±60	120×26×100	525	£44.75	£38.91

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Ultra-fi specifications:
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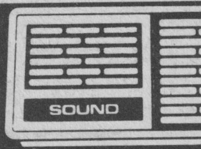

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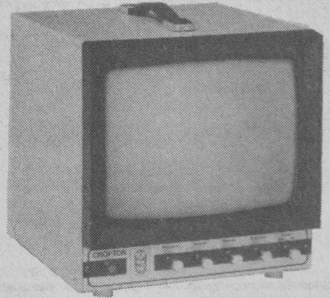

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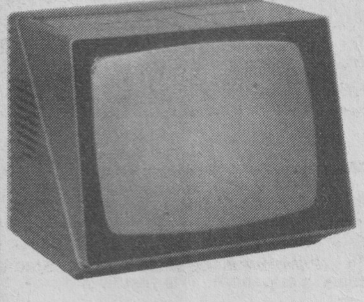

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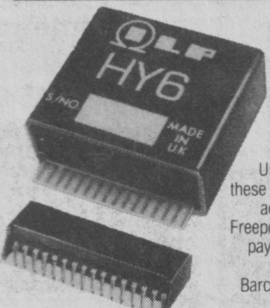

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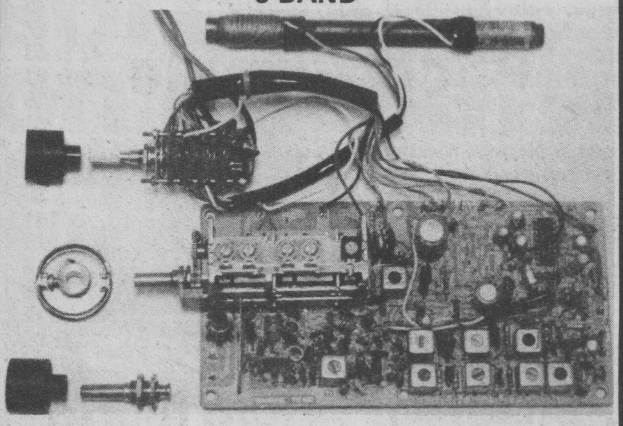

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For ZX81 with 16K RAM pack

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Cassette 5 – Junior Education: 9-11-year-olds

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